An Experimental Study of the Investment Implications of Bankruptcy Laws*

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Abstract

In bankruptcy laws, proportionality is the universal norm when allocating the liquidation value of a bankrupt firm among creditors. The theoretical literature on bankruptcy proposes two prominent alternatives to proportionality: the equal awards and the equal losses principles. We use an experiment to analyze and compare actual creditor behavior under these three principles. More specifically, we test the following hypotheses: replacing proportionality with equal losses increases total investment while replacing proportionality with equal awards decreases total investment; under all three principles individual investment choices decrease in response to an increase in the probability of bankruptcy or an increase in risk aversion; total investment difference between proportionality and either of the other two principles is independent of the probability of bankruptcy as long as both induce an interior equilibrium. The results of the nonparametric tests and random effects Tobit regression analyses we conduct on our experimental data offer support for all hypotheses.

Keywords: bankruptcy, investment game, experiment, proportional, equal losses, equal awards, investment.

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1 Introduction

Bankruptcy is a central economic issue with important consequences.[1] As a result, procedures on the liquidation of a bankrupt firm and its allocation among creditors exist in bankruptcy laws of every country.[2] One common feature of bankruptcy regulations around the world is that the value of a liquidated firm is allocated in proportion to the claims of the creditors.[3]

The theoretical literature following the seminal work of O'Neill (1982) focused on (axiomatic) evaluation of solutions to bankruptcy problems, with the intention of producing "desirable" proposals. Additional to the *proportionality principle*, which characterizes the real-life bankruptcy regulations mentioned in the previous paragraph, this literature produced two other central principles. The *equal awards principle* requires equalizing the amount each creditor receives after bankruptcy and the *equal losses principle* requires equalizing the losses the creditors incur. The following example demonstrates differences between the three.

Example 1 *Suppose there are two creditors who respectively invest* 1000 *and* 2000 *USD in a firm that goes bankrupt. Assume that the liquidation value of the bankrupt firm is* 1800 *USD. For this bankruptcy problem, the proportionality principle suggests that the agents' shares be proportional to their original investments, that is, proposes the allocation* $x_P = (600, 1200)$*. The equal awards principle suggests dividing the firm's liquidation value equally among the creditors, that is, proposes the allocation* $x_{EA} = (900, 900)$*. Finally, the equal losses principle suggests dividing the firm's loss in value (i.e. 3000-1800=1200 USD) equally among the creditors, that is, proposes the allocation* $x_{EL} = (400, 1400)$*.*

The axiomatic literature on bankruptcy problems studies an abundance of allocation rules, almost every one of which is based on one or more of these three principles. Among them, some are purely based on one principle (such as the Proportional, Constrained Equal Awards, Piniles, or Constrained Equal Losses rules) and some apply different principles on different problems (such as the Talmud, the ICI family, or the Parametric family of rules).[4] However, neither the axiomatic literature, nor the more applied corporate finance literature on bankruptcy (discussed in the next section) does address the question of why in actual practice the proportionality principle has been preferred over the other two alternatives, or to any mixed application of these three principles. The answer might lie in the fact that the three principles are very different in terms of how they incentivize the

[1] For example, in US between 1999 and 2009, more than 551000 firms filed for Chapter 7 bankruptcy and more than 22.16 billion USD were allocated in these cases (see http://www.justice.gov/ust/index.htm).

[2] For examples, see Chapter 7 of the U.S. Bankruptcy Code or the Receivership code in U.K. In some countries such as Sweden or Finland, these procedures provide the only option for the resolution of bankruptcy. Bankruptcy laws of some other countries, such as U.S., also offer procedures (such as Chapter 11) for reorganization of the bankrupt firm.

[3] More precisely, the creditors are sorted by law into different priority groups (such as secured creditors or unsecured creditors). These groups are served sequentially. That is, a creditor is not awarded a share until creditors in higher priority groups are fully reimbursed. Second, in each priority group, the shares of the creditors are determined in *proportion* to their claims. Proportionality is a very old and common practice, referred to as a *pari passu* distribution; the term meaning "proportionally, at an equal pace, without preference" (see Black's Law Dictionary, 2004).

[4] For a formal description of these rules, please see Thomson (2003 and 2008). As an example, consider the celebrated Talmud rule. If the bankrupt firm's liquidation value is less than half of its total debt, the Talmud rule applies the equal awards principle. Otherwise, the equal losses principle is applied.

creditors and affect their investment behavior.

When comparing the incentives induced by these principles, it is useful to first note that (in case of bankruptcy) the proportionality principle offers all creditors the same rate of return on investment. On the other hand, the other two principles distinguish among bigger and smaller creditors (that is, creditors with higher or lower than the average investment). The equal losses principle favors bigger creditors by offering them a higher rate of return than does proportionality (and discriminates against smaller creditors by offering them a lower return than does proportionality). And the equal awards principle does the opposite.[5]

In an environment where investment is endogenous, one would thus intuit that, in comparison to proportionality, the equal losses principle provides incentives to increase investment to receive better treatment as a big creditor while the incentives created by the equal awards principle is just the opposite. Motivated by this intuition, Kıbrıs and Kıbrıs (2013) analyzes a noncooperative investment game with possible bankruptcy to compare alternative allocation rules in terms of how they affect equilibrium investment decisions. As detailed in Section 3, this study shows that a change in the underlying bankruptcy principle affects the equilibrium investment of a creditor through (*i*) a direct effect on her marginal return on investment (in line with the above intuition), as well as (*ii*) an indirect effect through other creditors' choices (which the initial intuition does not account for and which can possibly counteract the first effect). Interestingly, Kıbrıs and Kıbrıs (2013) shows that when investment is aggregated across creditors, the direct effect dominates the indirect one. Thus, (*a*) switching from proportionality to equal losses increases total equilibrium investment, and (*b*) switching from proportionality to equal awards decreases total equilibrium investment. This theoretical conclusion, if it can be confirmed by experimental studies, provides a social planner with a strong policy tool to affect investment behavior.

The *objective of this paper* is to analyze in an experimental setting the implications of replacing the proportionality principle in bankruptcy laws with the equal losses and equal awards principles. Motivated by the previous paragraph, we are particularly interested in seeing if this institutional change impacts upon the total investment of creditors in ways consistent with the theoretical results from which we derive our empirical hypotheses stated below.

Hypothesis 1: Replacing the proportionality principle with equal losses in turn increases the creditors' total investment and the amount of increase is independent of the probability of bankruptcy as long as both principles induce an interior equilibrium.

Hypothesis 2: Replacing the proportionality principle with equal awards in turn decreases the creditors' total investment and the amount of decrease is independent of the probability of bankruptcy as long as both principles induce an interior equilibrium.

To test these hypotheses as well as two others that are stated below, we construct a simple experiment with two stages. In the first stage, we use a common technique (due to Holt and Laury, 2002) to elicit subjects' risk aversion levels, parameterized as a_i. Since in real life, bankruptcy happens probabilistically, we expect that the probability of bankruptcy

[5] To see this in the above example, note that the proportionality principle awards both creditors 60% of their investment. On the other hand, the equal losses principle awards creditor 1, the smaller creditor, only 40% of her investment, but awards the second creditor 70% of her investment. Finally, the equal awards principle awards creditor 1 90% of her investment, and awards creditor 2, only 45% of her investment.

as well as the creditors' risk attitudes will be important determinants of behavior (as stated in hypotheses 3 and 4 below). In the second stage of the experiment, subjects are randomly matched into pairs and in each pair, the 2 creditors simultaneously choose how much money to invest in a firm (say s_1 and s_2). The total of the two investments determine the value of the firm ($v = s_1 + s_2$). The firm is a lottery which either brings a positive return (with a probability π, called hereafter the *success probability*) or goes bankrupt (with the remaining probability $1 - \pi$). In the former case, the firm distributes dividends with an *interest* r, so creditor i receives $(1 + r)s_i$. In the latter case, that is *bankruptcy*, only β fraction of the firm's initial value survives. This value, βv, is allocated among the creditors according to the pre-specified bankruptcy principle known to the creditors before they make their investment decisions.

Using the above notation, we can state our next hypotheses as follows:

Hypothesis 3: Under all three principles, an increase in the probability of bankruptcy (*i.e.* a decrease in π) in turn decreases the creditors' investment choices.

Hypothesis 4: Under all three principles, an increase in a creditor's own risk aversion (*i.e.* a_i) in turn decreases her investment choice.

Hypotheses 3 and 4 are intuitive statements that, independent of the underlying bankruptcy principle, we expect real life creditors facing possible bankruptcy of their investment would satisfy. They thus serve to check whether our experimental design is a good representation of real life bankruptcy environments.

Following Kıbrıs and Kıbrıs (2013), the subjects in the experiment move simultaneously when making investment decisions. However, in the Conclusion, we briefly discuss findings from a numerical analysis that we carried out to see the implications of sequential interaction.

For reasons that will be discussed in Section 4 (see Footnote 14 and the related paragraph), we do not provide subjects with information about others' risk attitudes. Nonetheless, we present in the Appendix (*Subsection 7.4*) results on additional treatments where we provide information about others' risk group (*i.e.* a set of risk parameters) and show that this information does not affect investment behavior. The Appendix (*Subsection 7.5*) additionally contains an analysis of the determinants of extreme investment behavior.

The paper is organized as follows. In *Section 2*, we present the related literature. In *Section 3*, we discuss the Kıbrıs and Kıbrıs (2013) model. In *Section 4*, we present our experimental design and procedures. In *Section 5*, we discuss the data produced by the experiment and we present our statistical analyses and results. We conclude in *Section 6*. All supplementary material, including the instructions for the experiment, are presented in *Section 7, the Appendix.*

2 Related Literature

Being a very important economic issue, bankruptcy has attracted scholarly attention in a wide variety of fields, the most relevant of which will be discussed next.

Starting with the seminal papers of O'Neill (1982), and Aumann and Maschler (1985), the *axiomatic* literature analyzes properties of alternative bankruptcy rules, which are based on one or more of the three basic principles of proportionality, equal awards, and equal losses. It, however, remains silent on their investment implications. Thomson (2003 and 2008) presents a detailed review of this literature, together with an extensive inventory of the rules analyzed.

The *corporate finance* literature also contains a large number of papers that study bankruptcy. Among them, it is particularly useful to mention Hotchkiss *et al* (2008) which summarizes bankruptcy laws in different countries, Stromberg (2000) which uses Swedish data to evaluate liquidation procedures, and Bris, Welch, and Zhu (2006) which uses a comprehensive data set from the US to compare liquidation and reorganization procedures in terms of costs and efficiency. Even though this literature is extensive, it takes the proportionality principle as given and does not consider the implications of alternatives.

There is also a *game theoretical* literature on bankruptcy problems. Aumann and Maschler (1985), Curiel, Maschler, and Tijs (1987), and Dagan and Volij (1993) relate bankruptcy rules to cooperative game theoretical solutions. Chun (1989), Dagan, Serrano, and Volij (1997), Herrero (2003), Gonzalez-Diaz, and Villar (2006), and Chang and Hu (2008) present noncooperative games that implement different classes of bankruptcy rules. Eraslan and Yılmaz (2007) and the literature cited therein analyze negotiation games that arise during reorganization of the bankrupt firm. This literature also remains silent on the question of how bankruptcy rules affect the creditors' investment incentives.

Surprisingly, the *experimental* literature on bankruptcy is rather thin. There are only a few papers. Gächter and Riedl (2005) studies an environment where subjects bargain over a resource that falls short of the sum of their claims (as typical in bankruptcy) and inquires which of the three main principles (proportionality, equal awards, equal losses) is a better predictor of behavior. This study finds that while the subjects demand for themselves shares that are consistent with the equal awards principle, their sharing suggestions for others are consistent with proportionality. Gächter and Riedl (2006) studies how the differences between the subjects' claims affect offers, duration, concessions, and (dis)agreements in negotiations. Herrero, Moreno-Ternero and Ponti (2010) asks subjects to play three games with different frames. In the games, three group members have claims over the shrunk value of a project. Each subject declares which of the three principles she prefers. The experiment is designed so that the allocation according to each principle favors exactly one of the claimants. This study first analyzes which principle is chosen under these conditions. Then it analyzes which principle is chosen if the implemented principle is determined according to the majority rule. It finds that while subjects' play converges to the unique equilibrium principle (that is, each player chooses the principle that favors her), in the majority procedure the proportional principle prevails as a coordination device. Cappelen *et al* (2015) generates situations where participants work and accumulate claims in firms, some of which subsequently go bankrupt. Randomly chosen third-party arbitrators are then asked to allocate the bankrupt firm's liquidation value among the claimants. The paper finds that almost 85% of the arbitrators support proportionality. Arbitrators also show significant support for the equal losses principle, while the equal awards principle receives almost no support.

Thus, earlier experimental studies (mentioned above) have all focused on the allocation stage of bankruptcy and tried to see how good a predictor of demand (or arbitrator) behavior the three principles of proportionality, equal awards, and equal losses are. We, on the other hand, do not take these principles as predictor of behavior. But rather, we take each as a fixed parameter of the environment where a group of creditors interact and we try to see how the choice of principle affects the agents' investment choices. Our experiment is thus a very simple and stylized version of a real investment environment.

The closest theoretical papers to our experiment are Kıbrıs and Kıbrıs (2013) and, to a lesser extent, Karagözoğlu (2014) both of which use game theoretic models to analyze investment implications of a class of bankruptcy rules. Since our experimental design is similar to the game theoretic model of Kıbrıs and Kıbrıs (2013), we will next discuss this paper in more detail.

3 Theoretical Framework and Hypotheses

Our experimental design is similar to the theoretical model of Kıbrıs and Kıbrıs (2013). In this section, we summarize the findings of this paper in relation to our hypotheses. For formal proofs, please see Kıbrıs and Kıbrıs (2013).

The set of creditors is $N = \{1, ..., n\}$. The creditors are endowed with Constant Absolute Risk Aversion (CARA) utilities on money, $u_i(x) = -e^{-a_i x}$, and ordered according to their degrees of risk aversion as $a_1 \leq ... \leq a_n$. Each creditor i *invests* $s_i \in \mathbb{R}_+$ units of wealth on a risky company. The company has value $v = \sum_N s_i$ after investments. With *success probability* $\pi \in (0, 1)$, this value brings a *return* $r \in (0, 1]$ and becomes $(1 + r) \sum_N s_i$. In this case, each creditor i receives a dividend of $(1 + r)\, s_i$. With the remaining probability $(1 - \pi)$, the company goes bankrupt and its value becomes βv where $\beta \in (0, 1)$ is the *fraction that survives bankruptcy.* This amount is allocated among the creditors according to a pre-specified principle.

Among the bankruptcy principles analyzed in Kıbrıs and Kıbrıs (2013), the following three are central. The *Proportional Principle (PRO)* is defined as follows: for each creditor i, $PRO_i(s) = \beta s_i$, that is, in case of bankruptcy each creditor receives a share proportional to her investment. The *Equal Awards Principle (EA)* is defined as $EA_i(s) = \frac{\beta}{n} \sum_N s_j$, that is, in case of bankruptcy all creditors receive the same share, independent of their investment levels. Finally, the *Equal Losses Principle (EL)* is defined as $EL_i(s) = s_i - \frac{1-\beta}{n} \sum_N s_j$, that is, in case of bankruptcy all creditors lose the same amount ($\frac{1-\beta}{n} \sum_N s_j$) out of their initial investments.

Kıbrıs and Kıbrıs (2013) analyzes pure strategies and obtains the following results. Under PRO, the investment game has a unique dominant strategy equilibrium and no other Nash equilibria. If returns in case of success outweigh the losses incurred in case of bankruptcy, all creditors choose in equilibrium a positive investment.[6] The investment games under EA and EL do not admit dominant strategy equilibria. However, they both admit a unique Nash equilibrium. Under both principles, if returns in case of success outweigh the losses incurred in case of bankruptcy and if the creditors are not too different from each other in terms of their risk attitudes, the investment game admits an interior equilibrium

[6] This condition is formally stated as $\pi r > (1 - \pi)(1 - \beta)$. It compares the return on unit investment in case of success, r, weighted by the probability of success, π, with the loss incurred on unit investment in case of bankruptcy, $(1 - \beta)$, weighted by the probability of bankruptcy, $(1 - \pi)$. The two other bankruptcy principles also have similar conditions, as will be seen below. Under this condition, the equilibrium investment of creditor i is

$$s_i^{PRO} = \frac{1}{a_i\,(r + 1 - \beta)} \ln\left(\frac{\pi r}{(1 - \pi)(1 - \beta)}\right).$$

where all creditors choose a positive investment.[7,8]

Kıbrıs and Kıbrıs (2013) finds that a switch from PRO to EL increases marginal return on investment (by making losses from bankruptcy less sensitive to investment), thus providing incentive to increase investment. A switch from PRO to EA, on the other hand, has the opposite effect.[9] Equilibrium investment decision of a creditor is determined by a combination of this direct effect with a secondary indirect effect through other creditors' investment choices.

Under EL, the creditors' investment choices are strategic substitutes (that is, the best response of a creditor is decreasing in the total investment of other creditors). Thus, the direct and the indirect effect work in opposite directions (and it is possible that the indirect effect dominates the direct one). When investment is aggregated across creditors, however, Kıbrıs and Kıbrıs (2013) shows that the direct effect dominates the indirect one. Thus, switching from PRO to EL increases total equilibrium investment *(Hypothesis 1)*.

On the other hand, the creditors' investment choices are strategic complements under EA (that is, the best response of a creditor is increasing in the total investment of other creditors). Thus, the direct and the indirect effects work in the same direction. As a result, a switch from PRO to EA decreases total investment *(Hypothesis 2)*.

In footnotes 6, 7, and 8, we present the equilibrium investment choices under PRO, EL, and EA. A closer inspection of these expressions reveal that a creditor's equilibrium investment is decreasing in the probability of bankruptcy $(1-\pi)$ and in her own risk aversion a_i. These observations constitute *Hypothesis 3* and *Hypothesis 4* respectively. Total investment under PRO, EL, and EA are obtained by aggregating over creditors the individual investment levels given in footnotes 6, 7, and 8.[10] A simple analysis of these expressions reveal that total-investment differences are independent of the probability of bankruptcy $(1-\pi)$, as long as both principles induce an interior equilibrium. This observation constitutes the latter parts of *Hypothesis 1* and *Hypothesis 2*.

[7] For EA, these conditions can be respectively stated as $n\pi r > (1-\pi)(n-\beta)$ and $\frac{\frac{1}{a_n}}{\sum_N \frac{1}{a_j}} \geq \frac{r\beta}{n(1+r-\beta)}$. Then, the equilibrium investment of creditor i is

$$s_i^{EA} = \frac{n\,(r+1-\beta) + \beta a_i \sum_N \frac{1}{a_j}}{a_i n\,(r+1-\beta)\,(r+1)} \ln\left(\frac{n\pi r}{(1-\pi)\,(n-\beta)}\right).$$

[8] For EL, these conditions can be respectively stated as $n\pi r > (1-\pi)(1-\beta)$ and $\frac{\frac{1}{a_n}}{\sum_N \frac{1}{a_j}} \geq \frac{(1+r)(1-\beta)}{n(1-\beta+r)}$. Then, the equilibrium investment of creditor i is

$$s_i^{EL} = \frac{n\,(r+1-\beta) - (1-\beta) a_i \sum_N \frac{1}{a_j}}{a_i n\,(r+1-\beta)\,r} \ln\left(\frac{n\pi r}{(1-\pi)(1-\beta)}\right).$$

[9] More precisely, the marginal loss incurred on unit investment is $(1-\beta)$ in case of PRO, $(1-\beta)/n$ in case of EL, and it is $(1-\beta/n)$ in case of EA.

[10] The total investment levels in an interior equilibrium are given by $T_{PRO} = (\frac{\sum(1/a_i)}{r+1-\beta})\ln(\frac{\pi r}{(1-\pi)(1-\beta)})$ under PRO, $T_{EL} = (\frac{\sum(1/a_i)}{r+1-\beta})\ln(\frac{n\pi r}{(1-\pi)(1-\beta)})$ under EL, and $T_{EA} = (\frac{\sum(1/a_i)}{r+1-\beta})\ln(\frac{\pi r}{(1-\pi)(1-(\beta/n))})$ under EA.

4 Experimental Design and Procedures

The subjects for the experiment were recruited by using posters hanged around the Middle East Technical University campus. The participants were undergraduate students.[11] The experiment was computerized using z-tree (Fischbacher, 2007). In total, 352 subjects participated and there were 30 *sessions* in the experiment. Each subject participated in only one session and sessions lasted approximately 45 minutes. For payoffs, we used *tokens*, each token being equivalent to 0.01 Turkish Liras (TL). Each subject received 5 TL for participation, and also their winnings from each stage, as described below. On average, a subject earned 27.19 TL, including the 5 TL participation fee.[12]

The experiment had two stages. In the *first stage* of the experiment, we elicited the risk attitude of each subject by using the Holt and Laury (2002) method. Subjects were offered ten pairs of lotteries. Each lottery-pair, called a *Row*, was made up of two lotteries: a less-risky lottery called *Option A* and a more risky lottery called *Option B.* The subjects were asked to pick one option from each row. In Row 1, (the less-risky lottery) Option A has a higher expected payoff than (the more-risky lottery) Option B. Hence, only very strong risk lovers pick Option B in this row. Moving further down in the rows, the expected payoff difference between the lotteries in Option A and in Option B decreases and eventually turns negative in Row 5. In Row 10, subjects choose between a sure payoff of 400 tokens (Option A) and a sure payoff of 770 tokens (Option B). Since Option B offers a higher payoff in this last row, by then all subjects should have switched from Option A to Option B.[13] The payment for the first stage was determined according to the subject's lottery choice in a randomly chosen row. Payoffs from the first stage were only revealed at the end of the experiment.

The *second stage* of the experiment replicated an investment environment with possible bankruptcy, similar to the formal model described in the previous section. As will be detailed below, subjects were randomly paired and in each pair, the two subjects were asked how much they wanted to invest in a firm whose value would be the sum of the two subjects' investments. The invested firm became successful with a success probability π and paid interest r; or it went bankrupt and only a β fraction of its original value survived. In this latter case, the remaining value of the bankrupt firm was allocated among the subjects according to a pre-declared principle.

In the second stage we implemented a 3×3 design. Namely, we varied the bankruptcy principle (formally defined as EL, PRO, and EA in the previous section) and the success probability ($\pi = 0.3$, $\pi = 0.45$, or $\pi = 0.6$). In each session, we alternated between 2 bankruptcy principles. In particular, in 18 sessions we alternated between PRO and

[11] The average age of the subject group was 21.69 and 47% of the subjects were female. We did not ask the subjects if they know game theory. However, around 25% of the subject group was from the economics department. And, by looking at their ages we can predict that at least half of the 25% had an introduction to game theory in the second part of the intermediate microeconomics course. The remaining 75% of the subjects are from other departments where no game theory courses are offered.

[12] At the time of the experiment, 1 USD corresponded to 2.25 TL.

[13] In this choice task, a consistent subject should switch from Option A to Option B just once. However, earlier experiments using Holt and Laury's (2002) method showed that some subjects may go back and forth between Option A and Option B. To prevent such behavior in our experiment, we asked subjects the row number at which they wanted to switch from Option A to Option B (called the *switching point*). With these monetary payoffs, it is optimal for a risk-neutral subject to have a switching point of 5 (that is, to switch from Option A to Option B in Row 5). Similarly, it is optimal for a risk-averse (risk-loving) subject to have a switching point higher (lower) than 5.

Table 1: Description of Treatments

Success probability	0.3	0.3	0.45	0.45	0.6	0.6	0.3	0.3	0.45	0.45	0.6	0.6
Order	EL PRO EL PRO	PRO EL PRO EL	EL PRO EL PRO	PRO EL PRO EL	EL PRO EL PRO	PRO EL PRO EL	EA PRO EA PRO	PRO EA PRO EA	EA PRO EA PRO	PRO EA PRO EA	EA PRO EA PRO	PRO EA PRO EA
#Sessions	4	3	2	2	4	3	2	2	2	2	2	2
# Matching Groups	12	9	6	6	12	9	5	5	6	6	6	6
#Subjects	48	36	24	24	48	36	20	20	24	24	24	24

EL and in 12 of them, we alternated between PRO and EA. In all sessions we kept the fraction that survives bankruptcy (chosen $\beta = 0.4$) and the return rate in the case of success (chosen $r = 1$) constant.

Table 1 lists the different treatments we employed in the sessions we ran. Note that we define a *treatment* with a specific success probability and two bankruptcy principles alternating in a specific order.[14]

The second stage of each session was organized with a within-subject block design: in EL-PRO treatments, each subject went through 36 rounds alternating between EL and PRO every 9 rounds. Similarly, in EA-PRO treatments, subjects went through the same cycle of 9-round-blocks alternating between EA and PRO. For each success probability we alternated the order of bankruptcy principles across treatments to check for possible order effects.[15]

The sessions were computerized and we typically admitted 12 subjects to each.[16] At the beginning of each session, in order to avoid dependencies between all observations of one session, participants were divided into matching groups of 4. In a given round, the subjects interacted in pairs and during the 9 rounds of a given block, each subject was matched with every other member of this matching group exactly three times. The order of these matchings were also randomly determined. This procedure was not explicitly stated in the instructions but the subjects were told that while it is possible to be matched with the same person in two consecutive rounds, the person they are matched with will likely be different at each round.

At the beginning of the second stage, the subjects were informed that they would play 4

[14]The $\pi = 0.3$ and $\pi = 0.6$ treatments under EL-PRO principles were run earlier than the other treatments and included sessions where we provided part of the subjects with information about the teammate's risk attitude. As will be detailed in the Appendix (*Subsection 7.3*), we found that this information had no significant effect on a subject's investment decisions. Thus, in latter treatments we did not provide subjects any information on partner's risk attitude.

[15]It is also useful to note that, while each 9-round-block constitutes a repeated game, the theoretical predictions remain unchanged. Since the investment game has a unique Nash equilibrium under all three principles, the subgame perfect Nash equilibrium of the corresponding finitely-repeated game is also unique, and coincides with the stage game's unique Nash equilibrium.

[16]The only exception is 2 sessions (both EA-PRO treatments with $\pi = 0.3$) where we had 8 subjects due to low participation. (Since each matching group was composed of 4 subjects, the number of subjects in a session could be any multiple of 4.)

blocks of 9 identical rounds, that is, in total they would play 36 rounds. They were also told that before each block starts, they would be given information about the game they would play in that block. The Appendix (*Subsection 7.1*) presents the instructions we used under the EL, PRO, and EA treatments when $\pi = 0.6$ and when no information about partner is given.[17] The instructions for different success-rate treatments were similar.

At the beginning of each round (of the second stage), a subject was told that both she and her teammate were given 400 tokens each. Then, each subject had to choose how many tokens to invest in the team project. Total investment of the two team members determined the value of their team's project. Through randomization, this value either doubled (with probability 0.6, 0.45 or 0.3 in different treatments) or fell to 40% of its original value. If the project value doubled, a subject's payoff was twice the amount she invested (initial investment plus 100% return) plus the amount she did not invest. If the project value decreased to 40% of its original value, a subject's payoff was the amount she did not invest plus the share she received from the bankruptcy principle (EL, PRO, or EA) used in that treatment.[18] At the end of each round, a subject was informed about (*i*) the two investment choices (of her and her teammate), (*ii*) whether the project value increased or decreased (*i.e.* the result of the randomization), and (*iii*) both her and her teammate's payoffs in that round. Then, each subject was randomly and anonymously matched with another subject and the next round started.

At the end of each session, the subjects' payoffs were calculated from the first and the second stages. For the second stage, one round for each block (4 rounds in total) was randomly chosen and the total tokens won for that 4 rounds were given to the subject as the second stage payoff. In particular, we paid subjects based on a randomly selected subset of their decisions as well as a show-up fee. In a recent study, Azrieli, Chambers, and Healy (forthcoming) lay out the conditions under which this payment scheme (called Random Multiple Problem Selection, RMPS) is incentive compatible.[19]

When choosing the experiment parameters π, r, and β, we faced the following difficulty. Additional to these parameters, the point predictions of the Kıbrıs and Kıbrıs (2013) model depend on the agents' risk aversion parameters, which we do not control, but only observe at the time of the experiment. To be able to test our hypotheses, we thus chose the parameters π, r, and β so that for a wide range of risk aversion parameter combinations, (*i*) the theoretical model would predict positive investment levels that do not exceed the subjects' total endowments (*i.e.* interior solutions) and (*ii*) the theoretical "total investment" predictions under the two principles would be sufficiently different from each other. This is how $\pi = 0.45$ and $\pi = 0.6$ were chosen. Since our hypotheses (except the second statements of the first two) are expected to also hold for cases where the Kıbrıs and Kıbrıs (2013) model does not predict an interior equilibrium, we additionally included

[17] For the treatments in which we give information about partner's risk preferences, the subjects additionally saw the parts that we present in italics in the Appendix (*Subsection 7.1*).

[18] More specifically, PRO gave 40% of her investment to each subject. EL gave each subject her individual investment minus 30% of the project value (that is, half of the loss incurred due to bankruptcy). Finally, EA gave each subject 20% of the project value (that is, half of the value remaining after bankruptcy).

[19] RMPS is incentive compatible if preferences satisfy a generalized *Monotonicity* and a generalized *no complementarities at the top (NCaT)* assumption. Monotonicity requires that if, in every state of the world, a set A of lotteries pays in total more than an alternative set B of lotteries, then the decision maker should prefer A over B. NCaT requires that, given K menus, if we form a bundle by picking an alternative that the decision maker top ranks in each menu, this bundle is more preferred to every alternative bundle. Since in the experiments we did not elicit the subjects' preferences, we cannot check whether they satisfy these axioms.

Table 2: Summary Statistics for Investment

	EL-PRO sessions		
Success probability	EL	PRO	Pooled
$\pi = 0.3$	221.1 (135.4) n=1512	194.1 (137.6) n=1512	207.6 (137.2) n=3024
$\pi = 0.45$	290.8 (109.4) n=864	271.8 (118.0) n=864	281.3 (114.1) n=1728
$\pi = 0.6$	293.4 (110.9) n=1512	280.5 (116.8) n=1512	286.9 (114.0) n=3024
Pooled over Success probability	264.7 (125.6) n=3888	245.0 (132.0) n=3888	254.8 (129.2) n=7776

	EA-PRO sessions		
	EA	PRO	Pooled
$\pi = 0.3$	130.5 (119.9) n=720	165.3 (126.4) n=720	147.9 (124.4) n=1440
$\pi = 0.45$	186.4 (144.2) n=864	216.9 (142.6) n=864	201.7 (144.2) n=1728
$\pi = 0.6$	256.4 (134.2) n=864	289.1 (123.0) n=864	272.7 (129.7) n=1728
Pooled over Success probability	194.7 (143.1) n=2448	227.2 (140.4) n=2448	210.9 (142.7) n=4896

Average individual investment with respect to bankruptcy principle and success probability. Standard errors in parentheses

the parameter $\pi = 0.3$ (under which the theoretical model predicts zero investment under PRO).[20] A final concern when choosing the parameters was simplicity (*e.g.* $r = 1$), so as to minimize potential confusion of subjects.

In the instructions, we used the term “team project” for the firm, “team members” for the creditors of the firm, “increase and decrease in project value” for the success and bankruptcy of the firm, “contribution to the team project” for investment in the firm, and “the sharing scheme” for the bankruptcy principle.

5 Data and results

In Table 2, we summarize the individual investment levels in EL-PRO and EA-PRO sessions respectively, under the different bankruptcy principles and success probabilities. The

[20]These parameter combinations thus provide us with two additional tests. First, we test whether under $\pi = 0.3$, PRO is more likely to produce zero total investment. Second, we test whether the difference in the total investment levels induced by switching from PRO to either EL or EA depends on the value of π. The theoretical prediction is that this difference should be the same for $\pi = 0.45$ and $\pi = 0.6$.

table suggests that, on average, EL yields higher individual investment levels than PRO under all values of the success probability π, as well as when the data is pooled over these three values.

Wilcoxon signed-rank tests suggest that, average individual investment in matching groups is significantly higher under EL compared to PRO when the success probability is $\pi = 0.3$ (p-value $= 0.054$ and $n = 21$) and $\pi = 0.45$ (p-value $= 0.012$ and $n = 12$). The difference loses statistical significance when $\pi = 0.6$ (p-value $= 0.455$ and $n = 21$).

As can also be seen in Table 2, a higher success probability yields higher investment levels both under EL and PRO. In particular when we compare success probabilities $\pi = 0.3$ versus $\pi = 0.6$, we observe that investment levels increase by a factor of 1.44 under PRO and by a factor of 1.33 under EL. Wilcoxon rank-sum tests support this observation and indicate significantly higher average investment levels for higher success probabilities under both EL (p-value < 0.01) and PRO (p-value < 0.01) except for the comparison between $\pi = 0.45$ and $\pi = 0.60$ where the test statistics loses significance at 5%.[21]

Similar to EL-PRO sessions, mean investment levels under EA and PRO exhibit a substantial increase with higher success rates. In addition, across all different values of success rates, PRO is observed to induce higher investment compared to EA.

Wilcoxon signed-rank tests lend support for the difference between investment levels under EA and PRO for success probability $\pi = 0.6$ (p-value $= 0.034$ and $n = 12$). On the other hand, the difference is not significant when the success probability $\pi = 0.45$ (p-value $= 0.099$ and $n = 12$) or when $\pi = 0.3$ (p-value $= 0.169$ and $n = 10$). As for the effect of success rate on investment behavior, Wilcoxon rank-sum tests show that investment levels increase significantly (p-values < 0.01 for both EA and PRO) as success probability increases with the exception of the comparison between $\pi = 0.3$ and $\pi = 0.45$ where the increase in investment is not statistically significant at 5% level under either EA or PRO.

Since the success probability takes more than two values, we also performed a Kruskal-Wallis test using matching groups as a single unit of observation. Following this test, we performed multiple pairwise comparisons across success rates using Dunn's test for stochastic dominance (p-values were adjusted using Bonferroni corrections). We report the p-values from these analyses in Table A9 in the Appendix. As can be seen there, the results are qualitatively identical to those we obtained from the Wilcoxon signed-rank tests.

We present charts showing how subjects are distributed to different investment levels as well as the time trend for average individual investment under each bankruptcy principle and success probability in the Appendix (*Subsection 7.2*).

We continue our statistical analyses with a series of Tobit regressions to test each of the hypotheses listed in Section 3. Note that, while the first two hypotheses concern total investment, hypotheses 3 and 4 refer to individual investment levels. Consequently, in our regression models we match our level of analysis to the hypothesis we are testing and employ either individual investment or total investment as our dependent variable accordingly, while controlling for unobserved matching group level factors.

We model individual investment as a linear function of the bankruptcy principle, the

[21] All of our non-parametric tests are two-sided and use matching group averages, thus erring on the conservative side when drawing conclusions about significance.

success probability, as well as a subject's personal characteristics such as gender,[22] level of risk aversion and number of prior rounds in which she played with the same bankruptcy principle. Similarly, we model total investment, by which we mean the total investment of randomly matched pairs in each round, as a linear function of the bankruptcy principle, the success probability, as well as the gender composition of the pair and their level of risk aversion. Note that subjects were only allowed to invest nonnegative amounts and they were also constrained by the total amount of funds (400 tokens) available to them at each round. Consequently, to model the investment choices of our subjects, we employed a random effects Tobit regression analysis in which we accounted for unobserved group level factors with random effects. Here, by group we mean the matching groups of 4. The random effects model considers the matching group differences as random disturbances (rather than fixed) drawn from a normal distribution with mean zero.

Hypothesis 1 states that switching from PRO to EL increases total investment. We test this hypothesis at the matched-pair level with total investment as our dependent variable, and where unobserved factors at the matching-group are controlled with random effects. We control for bankruptcy principle, standardized success probability[23], familiarity with the bankruptcy principle measured by the number of times the pair has played with the principle in place, the first bankruptcy principle they played with, the gender composition of the pair (both male, both female, mixed), and finally the risk aversion level of the pair which we measure by the sum of their switching points in the Holt-Laury task. The results are presented on the left-most column in Table 3. Note that the reported estimates are marginal effects on the latent variable, which in our case, is uncensored total investment. The estimated coefficient for the *bankruptcy principle indicator* shows that switching from PRO to EL is on average associated with an increase of 42.7 tokens in (uncensored) total investment.

Hypothesis 1 also states that the total-investment difference between PRO and EL is independent of the probability of bankruptcy as long as both principles induce an interior equilibrium. To test this hypothesis, we rerun our model with the inclusion of an interaction variable between the bankruptcy principle and the success probability after limiting our sample to observations we obtained under $\pi = 0.45$ and $\pi = 0.6$. As noted earlier, this is because the independence argument follows from Kıbrıs and Kıbrıs (2013) which is silent for the case $\pi = 0.3$ (since in this case, the theoretical prediction is that total investment under PRO will be zero). The results which we report on the second column of Table 3 support the hypothesis. We still observe a substantial and significant jump in (uncensored) investment levels when we move from PRO to EL. Furthermore, the estimated coefficient for the interaction term between bankruptcy principle and success probability is statistically insignificant. In other words, the investment difference between the two bankruptcy principles remains unaffected by the probability of bankruptcy.

[22] A common finding in the literature is that women make more conservative retirement investments compared to men (*e.g.* see Bajtelsmit and VanDerhei, 1997; Bajtelsmit, Bernasek, and Jianakoplos, 1996; Hinz, McCarthy, and Turner, 1997; Yuh and Hanna, 1997). Moreover, our results indicate that gender is associated with the likelihood of making extreme (zero or full) investment choices. Thus, we control for gender in our regression models. Having said that, our main results are robust to the removal of gender variables.

[23] To standardize success probability we rescaled the variable to have a mean of zero and standard deviation of 1. Standardization makes it easier to compare success probabilities, and to read and interpret the results from the regression analyses.

Table 3: Results on Hypotheses 1 and 2

Results of Random Effects Tobit Regressions on Total Investment Random effects at the matching group level	EL vs. PRO		EA vs. PRO	
	Independent variable: Total Investment			
Bankruptcy Principle Indicator (EL=1, PRO=0 for EL vs PRO and EA=1, PRO=0 for EA vs PRO)	42.73*** (7.48)	41.50*** (3.64)	-69.23*** (-9.11)	-64.37*** (-4.79)
Standardized Success Rate	77.21*** (5.74)		101.09*** (5.40)	
Success Rate (High success rate (p=0.6)=1, Low success rate (p=0.45)=0)		26.58 (0.90)		158.92*** (3.46)
Sum total of subjects' switching points from option A to option B in stage 1 (from 0 to 10)	-7.13*** (-4.88)	-3.57*** (-2.16)	-4.98** (-2.20)	-5.68** (-2.07)
Number of rounds played under the same bankruptcy principle	4.13*** (7.49)	7.09*** (10.64)	1.53** (2.09)	2.63*** (2.87)
Bankruptcy principle in the first round (EL=1, PRO=0 for EL vs PRO and EA=1, PRO=0 for EA vs PRO)	15.87 (0.59)	-16.93 (-0.61)	-23.89 (-0.64)	-58.85 (-1.31)
Gender - both male (Both Male=1, Other=0)	16.50* (1.80)	34.48*** (3.25)	-27.52** (-2.47)	-14.49 (-1.01)
Gender - both female (Both Female=1, Other=0)	1.91 (0.24)	4.72 (0.51)	0.49 (0.04)	8.30 (0.53)
Interaction between bankruptcy principle and success rate		-12.76 (-0.90)		-8.55 (-0.45)
Constant	537.0*** (18.9)	529.3*** (14.99)	533.9*** (13.18)	515.5*** (9.72)
sigma_u	96.51***	76.37***	106.32***	107.26***
sigma_e	176.17***	165.66***	186.28***	195.74***
Number of Observations	3888	2376	2448	1728
Number of Matching Groups	54	33	34	24
Observations per matching group	72	72	72	72

z statistics in parentheses.* p < 0.1, ** p < 0.05, *** p < 0.01

Hypothesis 2 states that switching from PRO to EA reduces total investment. We test this hypothesis with the data we obtained from the second set of experiments in which we varied the bankruptcy principle between PRO and EA. We employ the same Tobit model we used to test Hypothesis 1. But this time our bankruptcy principle indicator is a dummy variable that takes on the value 1 when the principle in place is EA and 0 when it is PRO. The results, which we present on the third column of Table 3 provide strong support for the hypothesis. The estimated coefficient for the *bankruptcy principle indicator* shows that switching from PRO to EA is on the average associated with a decrease of 69.2 tokens in total (uncensored) investment.

We then turn to the latter part of *Hypothesis 2* which states that the total-investment difference between PRO and EA is independent of the probability of bankruptcy as long as both principles induce an interior equilibrium. To test this hypothesis, we rerun our model with the inclusion of an interaction variable between the bankruptcy principle and the success probability after limiting our sample to observations we obtained under $\pi = 0.45$ and $\pi = 0.6$. The results which we report in the right-most column of Table 3 provide empirical support for the hypothesis. We still observe a substantial and significant drop in (uncensored) investment levels when we move from PRO to EA. Furthermore, the estimated coefficient for the interaction term between bankruptcy principle and success probability is statistically insignificant. In other words, the investment difference between the two bankruptcy principles remains unaffected by the probability of bankruptcy.

Hypothesis 3 and *Hypothesis 4* refer to individual investment choices. Accordingly, to test these hypotheses we adapt the Tobit regression models we constructed to test *Hypotheses* 1 and 2 to the individual level. In other words, we regress individual level investments on individual level control variables while still accounting for random effects at the matching group level.

Hypothesis 3 states that under all three bankruptcy principles, an increase in the probability of bankruptcy (i.e. a decrease in π) in turn decreases the creditors' investment choices. The results in Table 4 offer strong support for this hypothesized association. The estimated coefficients for the *standardized success probability* under different bankruptcy principles indicate that a higher success probability is associated with a substantial increase in investment levels regardless of the bankruptcy principle in place.[24] In fact, a one standard deviation increase in the success probability is associated with an increase of about 60 tokens in (uncensored) individual investment under EA; 45 tokens in (uncensored) investment under EL; and more than 50 tokens in (uncensored) investment under PRO. These numbers correspond to an expected investment jump between 50 to 70 tokens from low ($\pi = 0.3$) to medium ($\pi = 0.45$) and from medium to high ($\pi = 0.6$) success probability.[25]

Hypothesis 4 states that an increase in the creditor's own risk aversion corresponds to a decrease in her investment level. The results we present in Table 4 also lend support to this hypothesis. A subject's risk-aversion level (as measured by the *her switching point in Holt-Laury*) turns out to be negatively associated with her investment levels under all bankruptcy principles. However, we must also note that we find a much more significant

[24]We replicated our analyses with a dummy (success rate) variable approach as well. Our results indicate that individual investment increases significantly as the success rate goes up except for the comparison between 0.45 and 0.6 under EL and 0.3 and 0.45 under EA. In other words, our regression results match the nonparametric test results we report above.

[25]Note that the mean value for π is 0.45 and its standard deviation is 0.132. The actual increment we use is 0.15 which corresponds to a 1.14 standard deviation.

association under EL and PRO. The significance of the estimated coefficient under EA barely reaches the 10% level.

Table 4: Results on Hypotheses 3 and 4

Results of Random Effects Tobit Regressions on Individual Investment Random effects at the matching group level	EL vs PRO under EL	 under PRO	EA vs PRO under EA	 under PRO
	Independent variable: Individual Investment			
Standardized Success Rate	46.02***	53.70***	63.55***	66.71***
	(4.35)	(6.01)	(4.38)	(4.74)
Stage subject switches from option A to option B in stage 1	-10.89**	-9.91**	-4.07*	-6.52**
(from 0 to 10)	(-6.91)	(-6.07)	(-1.64)	(-2.52)
Number of rounds played under the same bankruptcy principle	4.72***	1.12**	-0.26	2.11***
	(9.44)	(2.13)	(-0.39)	(2.98)
Bankruptcy principle in the first round	2.40	16.4	-33.51	-1.51
(EL=1, PRO=0 for EL vs PRO and EA=1, PRO=0 for EA vs PRO)	(0.11)	(0.91)	(-1.16)	(-0.05)
Gender (Male=1, Female=0)	24.46***	-8.88	-5.08	-19.95
	(4.10)	(-1.41)	(-0.58)	(-1.20)
Constant	307.31***	315.09***	251.28***	276.04***
	(15.70)	(17.53)	(9.30)	(10.23)
sigma_u	75.32***	62.32***	81.76***	78.86***
	(9.72)	(9.31)	(7.70)	(7.55)
sigma_e	152.74***	164.24***	168.44***	173.20***
	(64.93)	(65.52)	(52.30)	(50.94)
Number of Observations	3888	3888	2448	2448
Number of matching groups	54	54	34	34
Observations per matching group	72	72	72	72

z statistics in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Finally, nearly in all these regressions, we find a positive association between experience with the bankruptcy principle and the level of investment. We interpret this as a learning effect.

To make sure that our results are not driven by the specific statistical model we use, we repeated our analyses with random effects GLS regressions as well as linear OLS regressions with clustered errors at the matching group level. We present these analyses in the Appendix (*Subsection 7.6*). As can be seen in these tables, the GLS and OLS models yield similar results to the Tobit regressions we presented above and thus offer strong support for all our hypotheses.

6 Conclusion

We experimentally analyze the implications of switching from proportionality to either one of two other prominent principles (equal awards and equal losses) when allocating the value of a bankrupt firm. Our findings can be summarized as follows: Replacing the proportionality principle with equal losses increases the creditors' total investment by a positive amount that is independent of the probability of bankruptcy as long as both principles induce an interior equilibrium (*Hypothesis 1*). Replacing the proportionality principle with equal awards decreases the creditors' total investment by a positive amount that is independent of the probability of bankruptcy as long as both principles induce an interior equilibrium (*Hypothesis 2*). An increase in the probability of bankruptcy decreases a creditor's investment choice (*Hypothesis 3*). Also, an increase in a creditor's own risk aversion decreases her investment choice (*Hypothesis 4*).

In our opinion, the most important findings here are the first two: verification of Hypothesis 1 demonstrates an advantage of equal losses over the universally applied proportionality principle, which might be relevant for policy-makers. Hypothesis 2, on the other hand, establishes that replacing the proportionality principle in bankruptcy with equal awards would come with a cost, that is, it would reduce the creditors' total investment.

Verification of the independence of these findings from the probability of bankruptcy is quite surprising since it means that while proportionality, equal losses, and equal awards principles are quite distinct in terms of how they incentivize creditors, they are similar in terms of how, under them, the creditors respond to changes in the probability of bankruptcy.

In our opinion, hypotheses 3 and 4 are less surprising. We expect that, in most real life investment environments, a firm that is more likely to go bankrupt will attract less investment and a creditor that is more averse to risk will invest comparatively less.

In line with Kıbrıs and Kıbrıs (2013), our experiments analyze an environment where the creditors move simultaneously. Their behavior is thus free of any order effects that might arise in a sequential interaction. An analysis of sequential investment decisions is interesting in itself, and it is an open question whether our findings extend to it. However, theoretical and experimental analysis of this case turns out to be quite involved and we plan to undertake it in a future project. As a first step towards this direction, and to give the reader an idea about how sequential interaction affects investment behavior, we carried out numerical analyses under the experimental parameters $\pi \in \{0.3, 0.45, 0.6\}$, $r = 1$, and $\beta = 0.4$. Our results are presented in Tables A1, A2 and A3 in the Appendix (*Subsection*

7.3). As can be seen there, independent of whether it is creditor 1 or 2 who moves first, total investment under proportionality (which is independent of order effects, due to the dominant strategy equilibrium under this principle) still remains lower than total investment under equal losses and higher than total investment under equal awards. That is, hypotheses 1 and 2 extend to sequential-moves for these parameter combinations. This, however, should only be taken as an encouragement for further analysis in this direction; without a formal and experimental analysis, there is no way of making a general statement. The tables, on the other hand, establish that, in terms of total investment levels, there is no fixed ordering among the three versions of the game (that is, simultaneous-moves, creditor 1 moving first, and creditor 2 moving first). This is true even when the comparison is restricted to cases where creditors 1 and 2 have identical risk parameters. Then, the two versions of the sequential game naturally produce identical total investment levels, but their ordering with respect to the simultaneous-move version of the game is not fixed.

As discussed in Section 4 (see *Footnote 14* and the related paragraph), in the main body of the experiment we do not provide subjects with information about the other's risk parameter. However, in the Appendix (*Subsection 7.4*), we present results on sessions where, under PRO and EL principles, we provide information about others' risk group (*i.e.* a set of risk parameters). There we show this information to have no significant effect on a subject's investment behavior.

In the Appendix (*Subsection 7.5*), we also provide an analysis of the correlates of extreme investment behavior (*i.e.* zero or full investment) in our experiment. To summarize, we find that (*i*) replacing the proportionality principle with equal losses increases (respectively, decreases) the likelihood that the creditor will choose full (respectively, zero) investment; (*ii*) replacing the proportionality principle with equal awards decreases (respectively, increases) the likelihood that the creditor will choose full (respectively, zero) investment; (*iii*) experienced subjects are more likely to make extreme investment choices; and (*iv*) male subjects are more likely to make extreme investment choices.

Kıbrıs and Kıbrıs (2013) also compares the three principles in terms of the creditors' equilibrium social welfare, and finds that proportionality always induces a higher egalitarian social welfare than equal awards and equal losses.[26] A somewhat weaker conclusion also holds for utilitarian social welfare comparisons. Since an experimental test of these predictions requires the strong assumption that the subjects have CARA utilities, we refrain from presenting results on this front. However, a more detailed discussion of the issue, as well as a regression analysis, is available upon request.

As noted in the introduction, the axiomatic literature is abundant with bankruptcy rules that differ from each other in terms of which principle they apply to what type of problems; see Thomson (2003, 2008) for a comprehensive list. Rather than focusing on any one these specific suggestions, we follow Kıbrıs and Kıbrıs (2013) and focus on the three general principles that underly them. We hope our findings will provide basis for further research that looks into more specific policy recommendations. However, it is useful to mention that, along with the Proportional rule (PRO), the axiomatic literature contains two bankruptcy rules that are very closely related to EA and EL: the Constrained Equal Awards rule (CEA) (respectively, the Constrained Equal Losses rule (CEL)) equates gains (losses) subject to the constraint that no agent gains (loses) more than her investment.[27]

[26] Egalitarian and utilitarian measures of social welfare are respectively calculated as the minimum and sum of the creditors' equilibrium welfare levels.

[27] For experimental purposes, the (unconstrained) principles are much simpler than these bankruptcy

It turns out that the theoretical implications of Kıbrıs and Kıbrıs (2013) also apply to CEA (whenever CEA admits an equilibrium) and CEL (whenever CEL admits an equilibrium in which all agents choose positive investment levels). Furthermore, the constraints imposed by CEA and CEL are binding only in "more extreme" cases where the creditors significantly differ in their investment decisions.[28] Therefore, we expect that a study which specifically compares CEA, CEL, and PRO would obtain results similar to ours.

Another interesting research direction is regarding the success probability. While it is taken to be independent of the level of total investments both in Kıbrıs and Kıbrıs (2013) and in this study, one can imagine interesting real life examples where the probability of success increases in total investments in the project. A study of such cases is left for future research.

Finally, our experimental data does not support the theoretical prediction of Kıbrıs and Kıbrıs (2013) that total investment will be zero under $\pi = 0.3$. We believe there might be two sources of this tendency to invest non-zero amounts. First, the expected loss in case of bankruptcy is not too large.[29] Second, when endowed with a non-monetary utility of winning, experimental subjects might have preferred non-zero investments, similar to over-dissipation in contests (Sheremeta, 2010). This behavior persists even when subjects are explicitly instructed to invest zero in the contests (Brookins and Ryvkin, 2014). We think these two effects might be jointly contributing towards subject's tendency to invest non-zero amounts when $\pi = 0.3$. Further analysis of these predictions is left for future research.

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rules (which incorporate additional clauses on what to do in case of such constraints), and thus, they are easier to explain to the subjects.

[28] For example, such cases correspond to only 13.6% of our data that exhibits bankruptcy under EL and to only 17.6% of our data that exhibits bankruptcy under EA.

[29] In particular the expected loss is slightly above 10% of the invested amount when the success rate is 0.3. In addition, typical investment levels of $150 - 200$ observed for $\pi = 0.3$ corresponds to less than 50% of the pie, bringing the expected loss to around 5% of the endowment.

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7 Appendix

7.1 Instructions Used in the Experiment

[Participants of a session saw Part 1 and Part 2 sequentially. Part 1 of the experiment differed between treatment with and without risk information: In the treatments with risk information, in addition to the regular-font text, subjects also saw the italic text. In Part 2, as explained in Section 4, we used a within-subject design for bankruptcy principles. Before explaining the game in Part 2, subjects were informed that this part consisted of 36 periods, with 4 blocks of 9 identical decision periods in each block; and before the start of each block they would be given information that was relevant for the following 9 periods. (Once the block was over, they would receive information that would be relevant for the next 9 periods and so on.) In the same session, subjects either went through EL-PRO-EL-PRO or EA-PRO-EA-PRO (or with the reverse order). For instance, in EL-PRO-EL-PRO (EA-PRO-EA-PRO) sessions, subjects played the game according to EL (EA) in the first block, according to PRO in the second block, according to EL (EA) in the third block, and according to PRO in the last block. To avoid repetition, below we only present the instructions for EL, PRO, and EA once. The following instructions are for $\pi = 0.6$. Instructions used in treatments with different success-rates were similar.]

Welcome and thank you for participating in our experiment!

We will read the instructions together. Please do not touch the keyboard for now and listen to the instructions carefully.

This is an experiment about economic decision making. All participants will earn some money during the experiment. The money you earn might be different from the other participants earnings. This amount is dependent on your decisions as well as the decisions of other participants. Please do not talk to each other during the experiment. We will have to terminate the experiment if you violate this rule. We will now describe the experimental procedures. It is very important that you understand all the parts. Please raise your hand if you have a question.

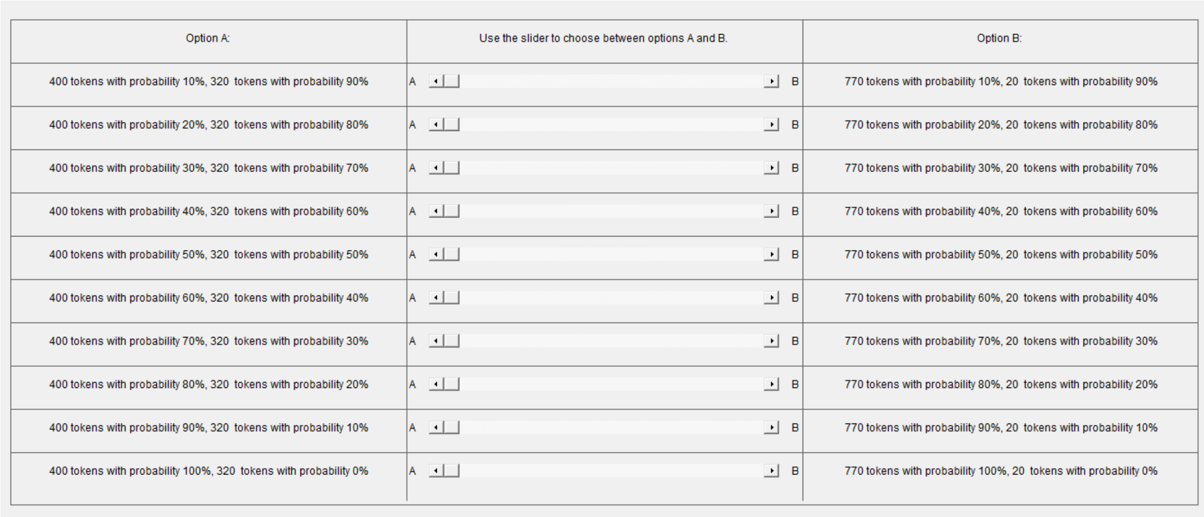
There will be two parts in our experiment. You will be instructed about each part before it starts. At the end of the experiment, you will learn about your total earnings from each part. Your earnings will be in tokens. 100 tokens corresponds to 1 TL. Your total earnings will be rounded to the nearest 25 kurus.[30] In addition to your earnings in the experiment, you will be paid a 5 TL participation fee.

PART 1

You will see a table like this in stage 1. In this part, you will face 10 different rows.

Each row provides two options, Option A and Option B. You will slide the bar in the middle to show which option you chose for that row. These options are basically lotteries that indicate your chances of winning a certain payoff. For each row, you will be asked to

[30] 1 TL is 100 kurus.



Option A:	Use the slider to choose between options A and B.	Option B:
400 tokens with probability 10%, 320 tokens with probability 90%	A B	770 tokens with probability 10%, 20 tokens with probability 90%
400 tokens with probability 20%, 320 tokens with probability 80%	A B	770 tokens with probability 20%, 20 tokens with probability 80%
400 tokens with probability 30%, 320 tokens with probability 70%	A B	770 tokens with probability 30%, 20 tokens with probability 70%
400 tokens with probability 40%, 320 tokens with probability 60%	A B	770 tokens with probability 40%, 20 tokens with probability 60%
400 tokens with probability 50%, 320 tokens with probability 50%	A B	770 tokens with probability 50%, 20 tokens with probability 50%
400 tokens with probability 60%, 320 tokens with probability 40%	A B	770 tokens with probability 60%, 20 tokens with probability 40%
400 tokens with probability 70%, 320 tokens with probability 30%	A B	770 tokens with probability 70%, 20 tokens with probability 30%
400 tokens with probability 80%, 320 tokens with probability 20%	A B	770 tokens with probability 80%, 20 tokens with probability 20%
400 tokens with probability 90%, 320 tokens with probability 10%	A B	770 tokens with probability 90%, 20 tokens with probability 10%
400 tokens with probability 100%, 320 tokens with probability 0%	A B	770 tokens with probability 100%, 20 tokens with probability 0%

Figure 1: Holt-Laury method in Part 1

choose one among Option A and Option B. Choosing Option B at some row automatically means that you choose Option B in all the rows below it.

For instance, consider Row 1. In Row 1 Option A offers 400 tokens with probability 1/10 and 320 tokens with probability 9/10. In Row 1 Option B offers 770 tokens with probability 1/10 and 20 tokens with probability 9/10.

Your earnings from this part will be determined as follows: First the system will pick a number between 1 and 10. This number will tell us the row that will be used in determining your earnings from this part.

Suppose that this number turns out to be 7 and that you have chosen Option A for row 7. The system will choose another number between 1 and 10. If this number is 7 or smaller (with probability 7/10), you will earn 400 tokens. If this number is 8 or larger (with probability 3/10), you will earn 320 tokens.

Before passing to Part 2, we will ask you to answer the following question: Which color do you like more? Blue or Green.

PART 2-[EL]

Block 1: (please see Figure 2)

At the beginning of each period, you will be matched with another subject randomly and you will form a team together. In each period, you can be matched with a person you are matched earlier or not. The identity of other team member will not be revealed to you at any time.

You will be given the following information about your teammate. Which color she likes more, blue or green, and whether she switched from Option A to Option B in the first *stage before or after Row 5. Similar information will be given to your teammate as well.*

At the beginning of each period, you will be given 400 tokens as your endowment. Then, you will decide how many of these tokens to contribute to the team project (between 0 and 400) and how many of them to keep in your private account. You will enter your contribution to the team project into the box on the screen.

Similarly, other person in your team will be given 400 tokens as her endowment. Then, she will be asked to choose how many of these tokens to contribute to the team project and how many of them to keep in her private account. Both your contribution and other team member's contribution can be any number between 0 and 400.

The value of the project will be determined as the sum of your and other team member's contributions. Once the value of the project is determined this way, we will randomly choose a number between 1 and 100. If it is 60 or lower (occurring with probability 60/100): The value of the project doubles. If it is higher than 60, the value of the project shrinks to 40% of its original value. If the value of the project doubles, period earnings for each team member will be 2 times her contribution to the project plus the tokens she keeps in her private account. If the value of the project shrinks to 40% of its original value, period earnings for each team member will be the tokens she keeps in her private account plus her contribution to the project minus half of the total loss (0.3 times total contributions)

After you and other team member state your contribution levels, you will observe the following on the screen: (*i*) Both your and other team member's contribution levels, (*ii*) Whether the value of team project increased or decreased, and (*iii*) Your earnings for that period.

This will be the end of the current period. You will then move on to the next period where you will be matched with someone to play the game again as we described earlier.

Example 1:

- Suppose you contribute 220 of your 400 tokens and you keep 180 tokens in your private account.
- Other team member contributes 280 of her 400 tokens to the team project and keeps 120 tokens in her private account.
- The value of the project is 220 + 280 = 500.
- Then a random number from 1 to 100 is selected and it comes out as 80 (higher than 60).
- The value of project becomes 500 × 0.4 = 200. The loss in the value of the project is 500 - 200 = 300
- Your period payoff is: 180 + 220 - 300/2 = 250.
- Other team member's period payoff is: 120 + 280 - 300/2 = 250.

Example 2:

- Suppose you contributed 200 of your 400 tokens and you keep 200 tokens in your private account.

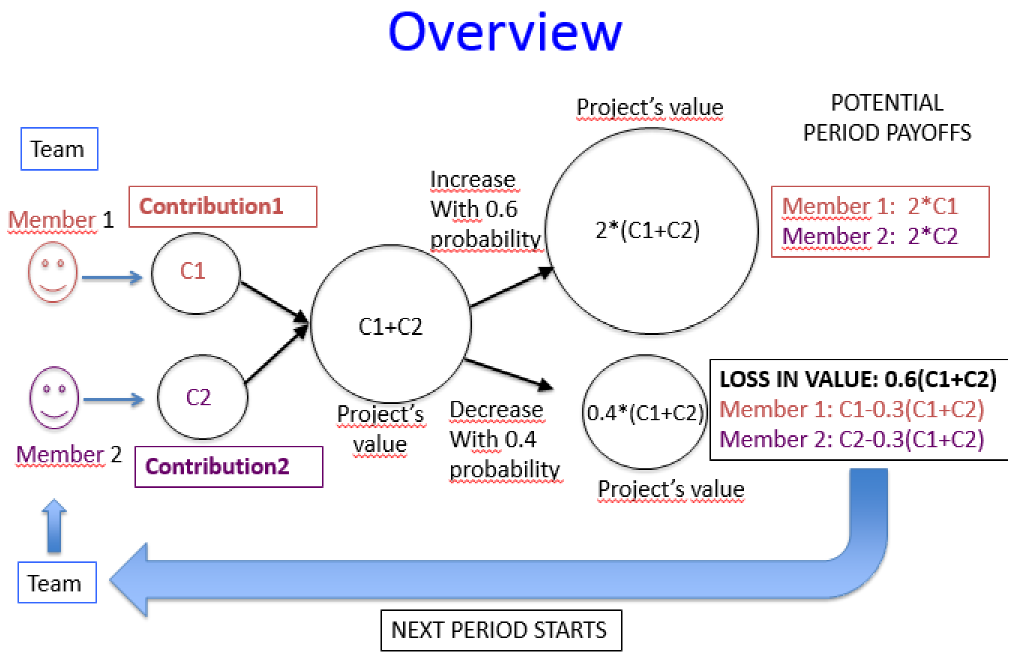


Figure 2: Overview of Part 2-EL

- Other team member contributed 240 of her 400 tokens to the team project and keeps 160 tokens in her private account.
- The value of the project is 200 + 240 = 440.
- Then a random number from 1 to 100 is selected and it comes out as 30 (lower than 60).
- The value of project becomes 440 × 2 =880.
- Your period payoff is: 200 + 200 × 2 = 600.
- Other team member's period payoff is: 160 + 240 × 2 = 640.

PART 2-[PRO]

Block 1: (please see Figure 3)

At the beginning of each period, you will be matched with another subject randomly and you will form a team together. In each period, you can be matched with a person you were matched earlier or not. The identity of other team member will not be revealed to you at any time.

At the beginning of each period, you will be given 400 tokens as your endowment. Then, you will decide how many of these tokens to contribute to the team project (between 0 and 400) and how many of them to keep in your private account. You will enter your contribution to the team project into the box on the screen.

Similarly, other person in your team will be given 400 tokens as her endowment. Then, she will be asked to choose how many of these tokens to contribute to the team project and how many of them to keep in her private account. Both your contribution and other team member's contribution can be any number between 0 and 400.

The value of the project will be determined as the sum of your and other team member's contributions. Once the value of the project is determined this way, we will randomly choose a number between 1 and 100. If it is 60 or lower (occurring with probability 60/100): The value of the project doubles. If it is higher than 60, the value of the project shrinks to 40% of its original value. If the value of the project doubles, period earnings for each team member will be 2 times her contribution to the project plus the tokens she keeps in her private account. If the value of the project shrinks to 40% of its original value, period earnings for each team member will be the tokens she keeps in her private account plus 40% of her contribution to the project.

After you and other team member state your contribution levels, you will observe the following on the screen: (*i*) Both your and other team member's contribution levels, (*ii*) Whether the value of team project increased or decreased, and (*iii*) Your earnings for that period.

This will be the end of the current period. You will then move on to the next period where you will be matched with someone to play the game again as we described earlier.

Example 1:

- Suppose you contribute 220 of your 400 tokens and you keep 180 tokens in your private account.
- Other team member contributes 280 of her 400 tokens to the team project and keeps 120 tokens in her private account.
- The value of the project is 220 + 280 = 500.
- Then a random number from 1 to 100 is selected and it comes out as 80 (higher than 60).
- The value of project becomes $500 \times 0.4 = 200$.
- Your period payoff is: 180 + 220*0.4 = 266.
- Other team member's period payoff is: 120 + 280*0.4 = 232.

Example 2:

- Suppose you contributed 200 of your 400 tokens and you keep 200 tokens in your private account.
- Other team member contributed 240 of her 400 tokens to the team project and keeps 160 tokens in her private account.
- The value of the project is 200 + 240 = 440.
- Then a random number from 1 to 100 is selected and it comes out as 30 (lower than 60).
- The value of project becomes $440 \times 2 = 880$.
- Your period payoff is: $200 + 200 \times 2 = 600$.
- Other team member's period payoff is: $160 + 240 \times 2 = 640$.

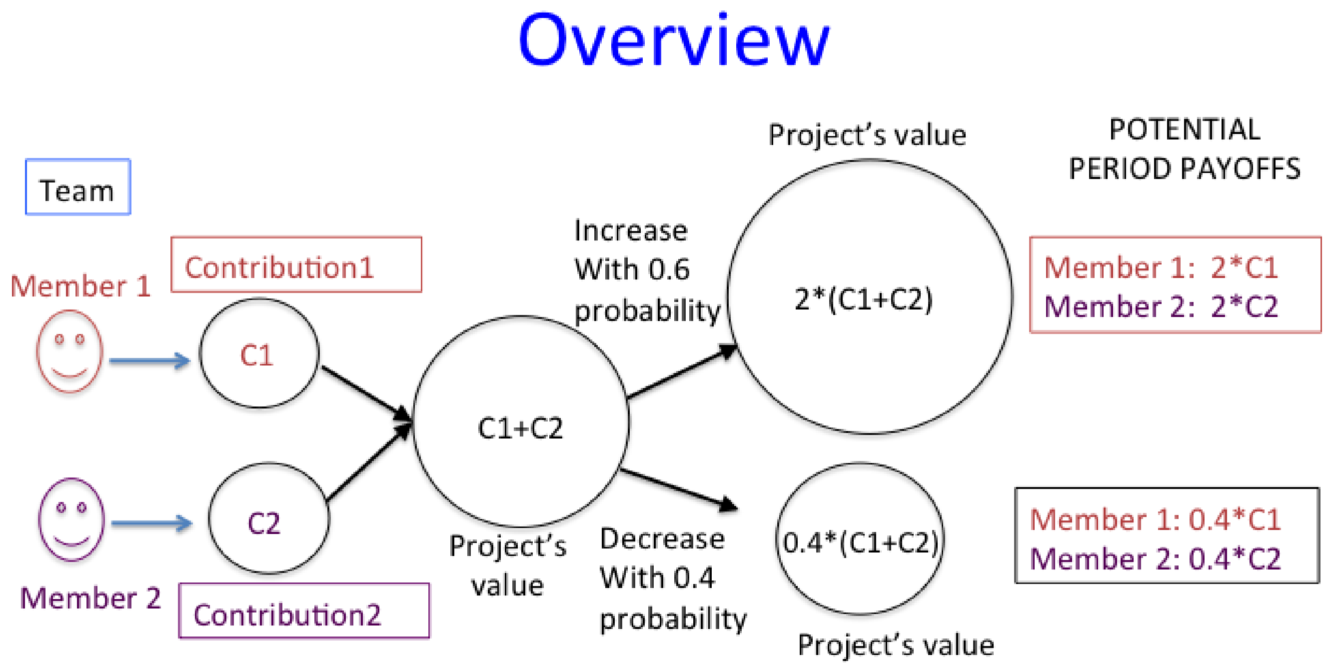


Figure 3: Overview of Part 2-PRO

PART 2-[EA]

Block 1: (please see Figure 4)

At the beginning of each period, you will be matched with another subject randomly and you will form a team together. In each period, you can be matched with a person you are matched earlier or not. The identity of other team member will not be revealed to you at any time.

At the beginning of each period, you will be given 400 tokens as your endowment. Then, you will decide how many of these tokens to contribute to the team project (between 0 and 400) and how many of them to keep in your private account. You will enter your contribution to the team project into the box on the screen.

Similarly, other person in your team will be given 400 tokens as her endowment. Then, she will be asked to choose how many of these tokens to contribute to the team project and how many of them to keep in her private account. Both your contribution and other team member's contribution can be any number between 0 and 400.

The value of the project will be determined as the sum of your and other team member's contributions. Once the value of the project is determined this way, we will randomly choose a number between 1 and 100. If it is 60 or lower (occurring with probability 60/100): The value of the project doubles. If it is higher than 60, the value of the project shrinks to 40% of its original value. If the value of the project doubles, period earnings for each team member will be 2 times her contribution to the project plus the tokens she keeps in her private account. If the value of the project shrinks to 40% of its original value, period earnings for each team member will be the tokens she keeps in her private account plus half of the current value of the project (0.2(C1+C2)).

After you and other team member state your contribution levels, you will observe the following on the screen: (*i*) Both your and other team member's contribution levels, (*ii*) Whether the value of team project increased or decreased, and (*iii*) Your earnings for that period.

This will be the end of the current period. You will then move on to the next period where you will be matched with someone to play the game again as we described earlier.

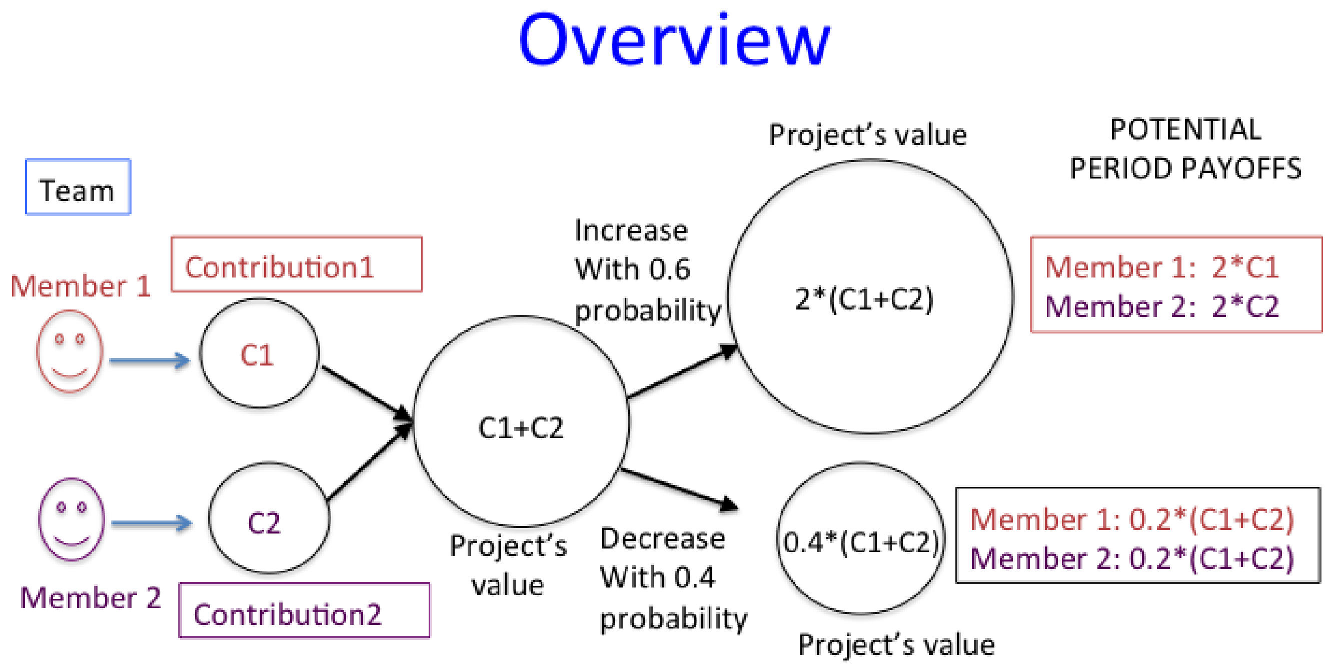


Figure 4: Overview of Part 2-EA

Example 1:

- Suppose you contribute 220 of your 400 tokens and you keep 180 tokens in your private account.
- Other team member contributes 280 of her 400 tokens to the team project and keeps 120 tokens in her private account.
- The value of the project is 220 + 280 = 500.
- Then a random number from 1 to 100 is selected and it comes out as 80 (higher than 60).
- The value of project becomes 500 × 0.4 = 200.
- Your period payoff is: 180 + 200/2 = 280.
- Other team member's period payoff is: 120 + 200/2 = 220.

Example 2:

- Suppose you contributed 200 of your 400 tokens and you keep 200 tokens in your private account.
- Other team member contributed 240 of her 400 tokens to the team project and keeps 160 tokens in her private account.
- The value of the project is 200 + 240 = 440.
- Then a random number from 1 to 100 is selected and it comes out as 30 (lower than 60).
- The value of project becomes 440 × 2 =880.
- Your period payoff is: 200 + 200 × 2 = 600.
- Other team member's period payoff is: 160 + 240 × 2 = 640.

7.2 Timetrend and distribution of individual investments

In *Figure 5*, we present the time trend for the average individual investments to the group project under each bankruptcy principle and success probability. Note that, in a given session subjects play under a fixed success probability and go through 4 blocks of 9 rounds, with the bankruptcy principle changing from one block to the next. The figure displays the first time EL and PRO is played (in blocks 1 and 2) on the left and the second time EL and PRO is played (in blocks 3 and 4) on the right. It shows that investment under EL rarely falls below that of PRO and this difference is especially prominent when the success probability takes its lowest value of $\pi = 0.3$. We also see that, in all cases but one (namely, PRO with $\pi = 0.3$), investment during final periods are higher than initial periods of the experiment.

The prevalence of higher investment under PRO compared to EA is documented for all success rates, with no specific time trend being observable in this figure .

Figure 6 presents histograms showing how the subjects are distributed to different investment levels (the horizontal axis). The top charts visualize the distribution in the EL-PRO sessions. Observe that a move from PRO to EL slightly increases the fraction of subjects who invest all their endowment. Additionally, a move from PRO to EL slightly decreases

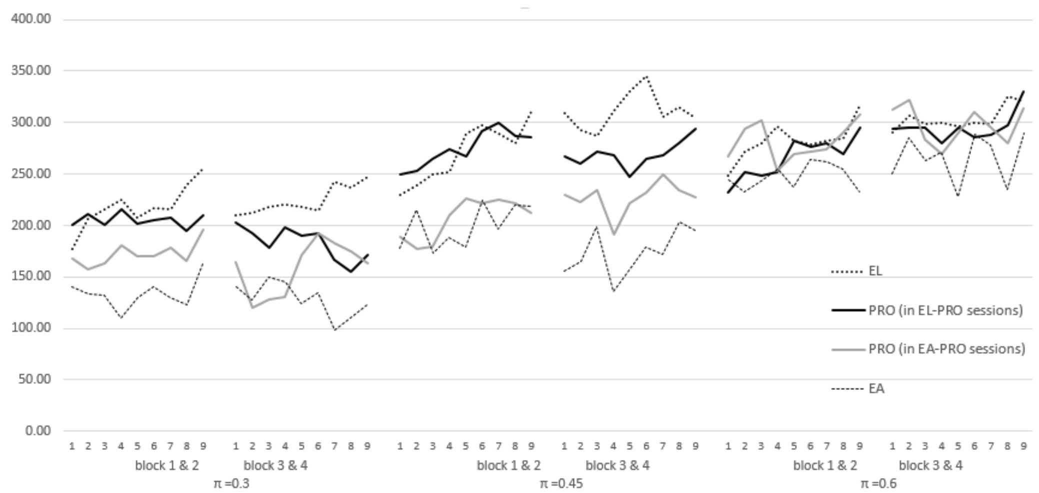


Figure 5: Time Trend of Investment

the fraction of subjects who choose zero investment. The bottom charts visualize the distribution in the EA-PRO sessions. Here, we observe that for the low success rate $\pi = 0.3$, a higher frequency of investments are clustered below 200 (half of endowment) for EA compared to PRO. On the other hand, for high success rates ($\pi = 0.45, \pi = 0.6\}$), the frequency of subjects investing all of their endowment is slightly higher under PRO compared to EA. A detailed analysis of extreme investment behavior in EA-PRO treatments is available in *Subsection 7.5*.

7.3 A Numerical Analysis of Sequential Investment Decisions

Tables A1, A2, and A3 present results of a numerical analysis where, for the case of two agents, we calculated the total investment levels under seven different versions of the investment game: *PRO* represents the dominant strategy equilibrium under simultaneous moves as well as the subgame perfect Nash equilibrium under sequential interactions; *EA-SIM* and *EL-SIM* represent the Nash equilibrium under simultaneous moves for principles EA and EL respectively; *EA-SEQ-1FIRST* and *EL-SEQ-1FIRST* represent (respectively for EA and EL) the subgame perfect Nash equilibrium of the sequential interaction when Creditor 1 moves first; finally *EA-SEQ-2FIRST* and *EL-SEQ-2FIRST* represent (respectively for EA and EL) the subgame perfect Nash equilibrium of the sequential interaction when Creditor 2 moves first. The first two columns of the tables, *a1* and *a2*, show the risk aversion parameters used for creditors 1 and 2 respectively. All numerical calculations are made for the experimental parameters $r = 1$ and $\beta = 0.4$. Table A1 assumes $\pi = 0.3$. Table A2 assumes $\pi = 0.45$. And Table A3 assumes $\pi = 0.6$. The results are discussed in the Conclusion section.

7.4 Implications of Information of the Partner's Risk Group

In Kıbrıs and Kıbrıs (2013), the partner's risk aversion has an effect on a player's equilibrium investment for the principles EL and EA, but not for PRO. In the current experiment, Wilcoxon rank-sum tests fail to find a difference between the sessions where information

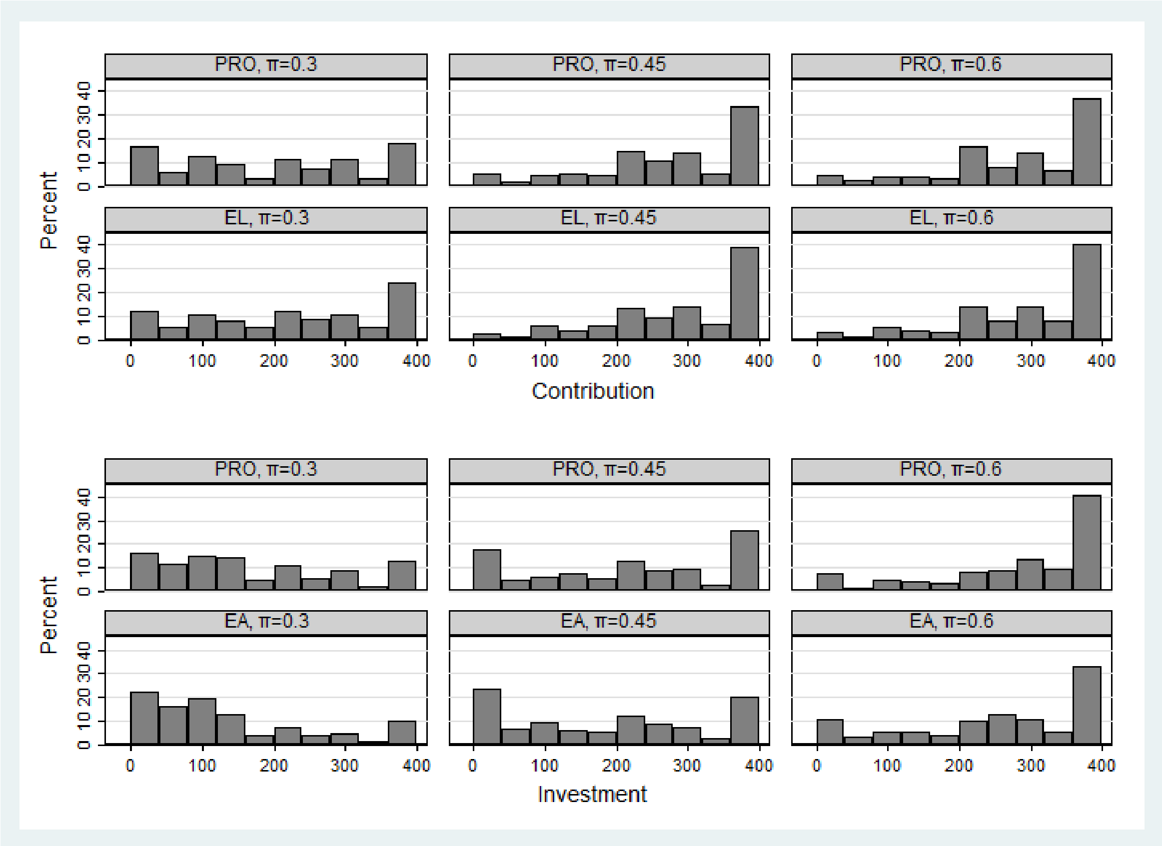


Figure 6: Histograms of Investment in EL-PRO Sessions (top) and EA-PRO Sessions (bottom)

on partner's risk was available versus when it wasn't. In particular for EL, the test results in a p-value = 0.943 when the success rate is 0.6 and in a p-value = 0.394 when the success rate is 0.3. Similar results are obtained for PRO, where we obtain a p-value = 0.722 when the success rate is 0.6 and a p-value = 0.477 when the success rate is 0.3. Further evidence comes from our regression analyses. When included in the regressions presented in Tables 3 and 4, the dummy variable "Availability of information on partner's risk attitude" (which takes on the value 1 if information was available and 0 if not) yields insignificant coefficients.[31]

Regarding this finding, two important points are worth mentioning. First, in the experiment the subjects received very coarse information about their partner's risk attitude.[32]. This significantly decreased the degree of variance in the information regarding the partner's risk attitudes, and consequently subjects were not able to differentiate the behavior of risk averse partners from the behavior of risk loving ones. The second point is related to the findings presented in Costa-Gomes and Weizsäcker (2008), pointing out that a subject pays more attention to the opponents' incentives when she is asked to state her beliefs about it. Since subjects were not asked to state their beliefs in the experiment, it might have been that they were not very sensitive to this information.[33]

[31] Results available upon request.
[32] An explanation for this specification in design is provided in Footnote 14.
[33] Büyükboyacı (2014) showed that even though subjects responded to their opponents' risk-aversion

7.5 Correlates of Extreme Investment Behavior

The results on the likelihood of extreme investment choices are presented in Table A4. The first column reveals that the likelihood of a subject investing all of her endowment (*i.e.* choosing full investment) is significantly higher (lower) under EL (EA) compared to the same likelihood under PRO, a finding consistent with Hypothesis 1 (Hypothesis 2). A higher success rate and a lower risk aversion level also increases the likelihood of full investment,

Additionally, the second column of Table A4 reveals that the likelihood of a subject investing nothing is significantly lower (higher) under EL (EA) compared to under PRO. Similarly, subjects are significantly less likely to choose zero investment under higher success rates. Compared to the case of full investment (column 1), risk aversion has a less significant effect on the likelihood of making zero investment, which seems to be determined mainly by the bankruptcy principle and the success rate.

Interestingly, "number of rounds played under the same bankruptcy principle" is observed to have a significant positive effect. That is, subjects become more likely to make these extreme choices (full or zero investment) as they gain more experience with a given principle. We also find a significant gender effect, suggesting that male subjects have a higher likelihood of making extreme investment choices compared to female subjects. This result is consistent with other findings in the literature (*e.g.* see Bajtelsmit and VanDerhei, 1997; Bajtelsmit, Bernasek, and Jianakoplos, 1996; Hinz, McCarthy, and Turner, 1997; Yuh and Hanna, 1997) which establish that women make more conservative retirement investments compared to men.

7.6 Robustness Checks

In this section, we present the regression results we obtain when we repeat our analyses with random effects GLS regressions as well as linear OLS regressions with clustered errors at the matching group level. As can be seen in tables A5, A6, A7, A8, the results remain very similar. Hence, our conclusions remain valid under these alternative model specifications as well.

information while choosing their actions, they did show no strategic sophistication on guessing how others may have chosen their actions with the same information.

Table A1: Total Investment Under Simultaneous and Sequential Interaction ($\pi = 0.3, r = 1, \beta = 0.4$)

a1	**a2**	**PRO**	**EA-SIM**	**EA-SEQ-1FIRST**	**EA-SEQ-2FIRST**	**EL-SIM**	**EL-SEQ-1FIRST**	**EL-SEQ-2FIRST**
0.005	0.005	0.00	0.00	0.00	0.00	89.17	124.10	124.10
0.005	0.0125	0.00	0.00	0.00	0.00	62.42	50.00	77.95
0.005	0.02	0.00	0.00	0.00	0.00	55.73	60.00	62.57
0.005	0.0325	0.00	0.00	0.00	0.00	55.90	50.00	54.87
0.005	0.05	0.00	0.00	0.00	0.00	56.62	50.00	54.87
0.005	0.07	0.00	0.00	0.00	0.00	57.00	50.00	54.87
0.0125	0.0125	0.00	0.00	0.00	0.00	35.67	45.03	45.03
0.0125	0.02	0.00	0.00	0.00	0.00	28.98	44.49	37.33
0.0125	0.0325	0.00	0.00	0.00	0.00	24.69	31.52	29.64
0.0125	0.05	0.00	0.00	0.00	0.00	22.29	30.00	21.95
0.0125	0.07	0.00	0.00	0.00	0.00	22.23	20.00	21.95
0.02	0.02	0.00	0.00	0.00	0.00	22.29	29.10	29.10
0.02	0.0325	0.00	0.00	0.00	0.00	18.01	23.83	21.41
0.02	0.05	0.00	0.00	0.00	0.00	15.60	20.87	21.41
0.02	0.07	0.00	0.00	0.00	0.00	14.33	20.00	13.72
0.0325	0.0325	0.00	0.00	0.00	0.00	13.72	16.13	16.13
0.0325	0.05	0.00	0.00	0.00	0.00	11.32	13.18	16.13
0.0325	0.07	0.00	0.00	0.00	0.00	10.04	11.61	16.13
0.05	0.05	0.00	0.00	0.00	0.00	8.92	13.18	13.18
0.05	0.07	0.00	0.00	0.00	0.00	7.64	11.61	13.18
0.07	0.07	0.00	0.00	0.00	0.00	6.37	11.61	11.61

Table A2: Total Investment Under Simultaneous and Sequential Interaction ($\pi = 0.45, r = 1, \beta = 0.4$)

a1	**a2**	**PRO**	**EA-SIM**	**EA-SEQ-1FIRST**	**EA-SEQ-2FIRST**	**EL-SIM**	**EL-SEQ-1FIRST**	**EL-SEQ-2FIRST**
0.005	0.005	77.54	5.62	13.61	13.61	250.83	285.12	285.12
0.005	0.0125	54.28	3.93	12.11	2.50	175.58	150.00	185.12
0.005	0.02	48.46	3.51	11.74	2.50	156.77	170.00	162.05
0.005	0.0325	44.73	3.24	11.50	2.50	157.25	150.00	154.35
0.005	0.05	42.65	3.09	11.36	2.50	159.27	150.00	154.35
0.005	0.07	41.54	3.01	11.29	2.50	160.35	150.00	154.35
0.0125	0.0125	31.02	2.25	1.00	1.00	100.33	115.59	115.59
0.0125	0.02	25.20	1.83	0.62	1.00	81.52	92.43	92.51
0.0125	0.0325	21.47	1.56	0.38	1.00	69.46	85.29	77.13
0.0125	0.05	19.38	1.40	0.25	1.00	62.71	70.00	69.43
0.0125	0.07	18.28	1.32	0.18	1.00	62.53	60.00	61.74
0.02	0.02	19.38	1.40	0.62	0.62	62.71	69.36	69.36
0.02	0.0325	15.66	1.13	0.38	0.62	50.65	62.21	53.97
0.02	0.05	13.57	0.98	0.25	0.62	43.89	53.90	46.28
0.02	0.07	12.46	0.90	0.18	0.62	40.31	50.00	46.28
0.0325	0.0325	11.93	0.86	0.38	0.38	38.59	46.82	46.82
0.0325	0.05	9.84	0.71	0.25	0.38	31.84	38.51	31.44
0.0325	0.07	8.73	0.63	0.18	0.38	28.25	34.10	31.44
0.05	0.05	7.75	0.56	0.25	0.25	25.08	30.82	30.82
0.05	0.07	6.65	0.48	0.18	0.25	21.50	26.41	23.13
0.07	0.07	5.54	0.40	0.18	0.18	17.92	18.72	18.72

Table A3: Total Investment Under Simultaneous and Sequential Interaction ($\pi = 0.6, r = 1, \beta = 0.4$)

a1	**a2**	**PRO**	**EA-SIM**	**EA-SEQ-1FIRST**	**EA-SEQ-2FIRST**	**EL-SIM**	**EL-SEQ-1FIRST**	**EL-SEQ-2FIRST**
0.005	0.005	229.07	157.15	158.73	158.73	402.36	432.22	432.22
0.005	0.0125	160.35	110.01	116.83	114.29	281.65	250.00	293.76
0.005	0.02	143.17	98.22	106.35	103.18	251.47	270.00	262.99
0.005	0.0325	132.16	90.66	99.63	92.07	252.25	250.00	247.61
0.005	0.05	125.99	86.43	84.76	92.07	255.50	250.00	247.61
0.005	0.07	122.72	84.19	82.77	80.96	257.22	250.00	247.61
0.0125	0.0125	91.63	62.86	61.27	61.27	160.94	175.97	175.97
0.0125	0.02	74.45	51.07	50.79	50.16	130.77	146.52	137.50
0.0125	0.0325	63.44	43.52	44.08	39.05	111.42	122.71	114.43
0.0125	0.05	57.27	39.29	40.32	39.05	100.59	110.00	106.73
0.0125	0.07	54.00	37.04	38.32	39.05	100.30	100.00	99.04
0.02	0.02	57.27	39.29	39.68	39.68	100.59	108.06	108.06
0.02	0.0325	46.26	31.73	32.97	28.57	81.25	91.94	69.59
0.02	0.05	40.09	27.50	29.21	28.57	70.41	78.61	77.29
0.02	0.07	36.82	25.26	27.21	28.57	64.66	71.53	69.59
0.0325	0.0325	35.24	24.18	21.86	21.86	61.90	68.86	68.86
0.0325	0.05	29.07	19.95	18.10	21.86	51.07	55.53	53.48
0.0325	0.07	25.80	17.70	16.10	21.86	45.32	48.46	45.79
0.05	0.05	22.91	15.72	18.10	18.10	40.24	40.15	40.15
0.05	0.07	19.63	13.47	16.10	18.10	34.49	40.76	40.15
0.07	0.07	16.36	11.23	16.10	16.10	28.74	33.07	33.07

Table A4: Results on Extreme Investment Choices

Results of Random Effects Probit Regressions on Binary Indicators of Extreme Investment
Random effects at the matching group level

	Independent variable:	
	Full Investment	Zero Investment
Bankruptcy Principle Indicator	0.137***	-0.275***
(EL=1, PRO=0)	(4.25)	(-4.97)
Bankruptcy Principle Indicator	-0.221***	0.164***
(EA=1, PRO=0)	(-5.12)	(3.10)
Standardized Success Rate	0.315***	-0.324***
	(5.45)	(-3.67)
Subject's switching point in Stage 1	-0.083***	-0.022*
(from 0 to 10)	(-10.18)	(-1.74)
Number of rounds played under the same bankruptcy principle	0.035***	0.037***
	(13.72)	(9.71)
Gender	0.312***	0.608***
(Male=1, Female=0)	(10.09)	(12.42)
Constant	-0.731***	-2.40***
	(-8.67)	(-17.94)
sigma_u	0.524***	0.770***
Number of Observations	12672	12672
Number of Matching Groups	88	88
Observations per matching group	144	144

z statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A5: Results on Hypotheses 1 and 2

Results of Random Effects GLS Regressions on Total Investment Random effects at the matching group level	EL vs. PRO		EA vs. PRO	
	Independent variable: Total Investment			
Bankruptcy Principle Indicator (EL=1, PRO=0 for EL vs PRO and EA=1, PRO=0 for EA vs PRO)	39.43*** (7.66)	37.90*** (3.75)	-65.07*** (-9.36)	-61.03*** (-5.07)
Standardized Success Rate	71.92*** (5.50)		95.08*** (5.10)	
Success Rate (High success rate (p=0.6)=1, Low success rate (p=0.45)=0)		22.49 (0.81)		145.33*** (3.17)
Sum total of subjects' switching points from option A to option B in stage 1 (from 0 to 10)	-6.22*** (-4.71)	-3.14*** (-2.14)	-5.09** (-2.44)	-5.75** (-2.32)
Number of rounds played under the same bankruptcy principle	3.47*** (7.01)	5.99*** (10.22)	1.43** (2.14)	2.39*** (2.92)
Bankruptcy principle in the first round (EL=1, PRO=0 for EL vs PRO and EA=1, PRO=0 for EA vs PRO)	14.02 (0.53)	-16.90 (-0.65)	-19.61 (-0.53)	-51.01 (-1.13)
Gender - both male (Both Male=1, Other=0)	16.66** (2.01)	32.90*** (3.50)	-30.13*** (-2.97)	-21.03* (-1.65)
Gender - both female (Both Female=1, Other=0)	1.73 (0.24)	3.98 (0.49)	2.39 (0.19)	10.20 (0.72)
Interaction between bankruptcy principle and success rate		-12.21 (-0.96)		-4.28 (-0.25)
Constant	525.3*** (19.69)	526.7*** (16.19)	527.1*** (13.65)	511.5*** (10.07)
sigma_u	94.21	72.63	106.26	108.28
sigma_e	160.47	148.46	172.16	176.94
Number of Observations	3888	2376	2448	1728
Number of Matching Groups	54	33	34	24
Observations per matching group	72	72	72	72

z statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A6: Results on Hypotheses 1 and 2

Results of OLS Regressions on Total Investment Clustered errors at the matching group level	EL vs. PRO		EA vs. PRO	
	Independent variable: Total Investment			
Bankruptcy Principle Indicator (EL=1, PRO=0 for EL vs PRO and EA=1, PRO=0 for EA vs PRO)	39.43*** (3.35)	37.90*** (3.54)	-65.07*** (-3.61)	-61.03** (-2.09)
Standardized Success Rate	72.62*** (5.63)		97.76*** (6.29)	
Success Rate (High success rate (p=0.6)=1, Low success rate (p=0.45)=0)		19.46 (0.68)		147.18*** (3.23)
Sum total of subjects' switching points from option A to option B in stage 1 (from 0 to 10)	-6.77** (-2.02)	-3.26 (-1.01)	-2.59 (-0.87)	-3.81 (-1.14)
Number of rounds played under the same bankruptcy principle	3.47*** (3.52)	5.99*** (6.52)	1.43 (1.31)	2.39* (1.98)
Bankruptcy principle in the first round (EL=1, PRO=0 for EL vs PRO and EA=1, PRO=0 for EA vs PRO)	16.75 (0.56)	-15.87 (-0.67)	-22.08 (-0.61)	-57.90 (-1.29)
Gender - both male (Both Male=1, Other=0)	26.42 (1.40)	27.85 (1.88)	-27.21 (-1.15)	-10.09 (-0.41)
Gender - both female (Both Female=1, Other=0)	2.54 (0.15)	15.54 (0.89)	-8.36 (-0.33)	-5.81 (-0.18)
Interaction between bankruptcy principle and success rate		-12.21 (-0.59)		-4.28 (-0.11)
Constant	530.4*** (11.21)	527.2*** (9.61)	497.1*** (12.14)	490.8*** (10.62)
Number of Observations	3888	2376	2448	1728
Number of Matching Groups	54	33	34	24
Observations per matching group	72	72	72	72

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A7: Results on Hypotheses 3 and 4

Results of Random Effects GLS Regressions on Individual Investment				
Random effects at the matching group level	EL vs PRO		EA vs PRO	
	under EL	under PRO	under EA	under PRO
	Independent variable: Individual Investment			
Standardized Success Rate	33.00***	38.25***	49.35***	47.21***
	(4.44)	(5.78)	(4.59)	(4.82)
Stage subject switches from option A to option B in stage 1	-6.93***	-6.47***	-3.14**	-4.17**
(from 0 to 10)	(-6.75)	(-5.84)	(-1.83)	(-2.44)
Number of rounds played under the same bankruptcy principle	2.91***	0.58	0.04	1.40***
	(8.72)	(1.59)	(0.09)	(2.99)
Bankruptcy principle in the first round	5.37	9.20	-19.07	-2.52
(EL=1, PRO=0 for EL vs PRO and EA=1, PRO=0 for EA vs PRO)	(0.36)	(0.69)	(-0.89)	(-0.13)
Gender (Male=1, Female=0)	13.84**	-6.82	-5.48	-16.71***
	(3.47)	(-1.58	(-0.91)	(-2.78)
Constant	272.38***	279.20***	227.32***	251.84***
	(20.22)	(21.71)	(11.66)	(13.69)
sigma_u	53.14	46.63	60.96	55.18
sigma_e	107.82	117.03	120.97	120.41
Number of Observations	3888	3888	2448	2448
Number of matching groups	54	54	34	34
Observations per matching group	72	72	72	72

z statistics in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01

Table A8: Results on Hypotheses 3 and 4

Results of OLS Regressions on Individual Investment				
Clustered errors at the matching group level	EL vs PRO		EA vs PRO	
	under EL	under PRO	under EA	under PRO
	Independent variable: Individual Investment			
Standardized Success Rate	33.31***	38.24***	49.44***	47.76***
	-4.33	(5.92)	(5.19)	(5.29)
Stage subject switches from option A to option B in stage 1	-5.97**	-8.04***	-1.32	-4.48
(from 0 to 10)	(-2.29)	(-2.79)	(-0.46)	(-1.45)
Number of rounds played under the same bankruptcy principle	2.91***	0.58	0.04	1.40**
	(5.55)	(0.80)	(0.06)	(2.14)
Bankruptcy principle in the first round	4.76	9.63	-18.55	-3.55
(EL=1, PRO=0 for EL vs PRO and EA=1, PRO=0 for EA vs PRO)	(0.32)	(0.78)	(-0.89)	(-0.18)
Gender (Male=1, Female=0)	21.61**	-9.29	-9.34	-10.25
	(2.34)	(-1.12)	(-0.73)	(-0.68)
Constant	263.02***	290.22***	217.52***	250.63***
	(13.05)	(12.83)	(9.30)	(10.75)
Number of Observations	3888	3888	2448	2448
Number of matching groups	54	54	34	34
Observations per matching group	72	72	72	72

t statistics in parentheses/ * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

7.7 Kruskal-Wallis and Pairwise Dunn Tests

Table A9: Success rate and investment behavior

	Kruskal-Wallis	Pairwise Dunn tests		
EL-PRO sessions		0.3 vs. 0.45	0.3 vs 0.6	0.45 vs 0.6
EL	0.001	0.009	0.0009	1
PRO	0.0001	0.0006	0	1
EA-PRO sessions				
EA	0.0004	0.197	0.0002	0.0197
PRO	0.0002	0.1635	0.0001	0.0156