METU Studies in Development, 44 (April), 2017, 27-46

# Loss sharing in partnerships

Mürüvvet Büyükboyacı
*Orta Doğu Teknik Üniversitesi, İktisadi İdari Bilimler Fakültesi, İktisat Bölümü, Ankara*
*e-mail: muruvvet@metu.edu.tr*

**Abstract**

I use an experiment to analyze individuals' choices for two well-known allocation rules proposed by the theoretical literature while sharing losses (bankruptcy situation): Equal Losses Rule (EL) and Proportional Rule (PRO). For the experiment, I use an investment game where individuals choose how much to contribute to a group project. The contribution of two individuals determines the value of the project. While this value rises with some probability (success rate), it shrinks (bankruptcy) with the remaining probability. In the case of success, investors obtain an interest that is proportional to their initial investment, and in the case of bankruptcy, they use either EL or PRO to share the shrunk value. In this game, given the symmetry for agents' risk aversion, a risk-neutral agent obtains the same expected payoff under both bankruptcy rules in equilibrium. However, depending on the individual's expectation about group's average investment level compared to her own investment level, an individual may prefer one rule to another. I first test how agents' rule choices differ depending on the success rate, their expected payoffs, which are calculated by using their beliefs about group's average investment, as well as some personal characteristics, like gender, and risk aversion. I observe that subjects expect their group members to invest as much as they do under both rules, and they are indifferent between the rules. I also observe that both rules induce similar investment levels, which are independent of subjects' risk aversion.

*Key words:* Bankruptcy, noncooperative investment game, proportional, equal losses, endogenous rule selection, partnership, experiment.

*JEL classification codes:* C72, C91, D78, G33.

## 1. Introduction

In real life, one can see partnerships in two different ways: professional service partnerships (such as in law, accounting, medicine, or real estate) and investment partnerships. In all of these cases, while forming the partnership, a group of investors first, need to agree on (i) how to allocate positive surplus in case of profits and (ii) how to allocate negative surplus in case of losses. In other words

they determine a rule for sharing for the success or failure of partnership's investments. By setting a rule before the investment, individuals can protect their investments. Specifically, if a person expects other group members to invest less than him, he may want to protect his investment by choosing one rule instead of other. In this paper, I try to understand what affects agents' rule choices for the allocation of loss. I also analyze the investment behavior of individuals when they are allowed to choose the rules for loss sharing.

Allocation of loss is very similar to the "bankruptcy problems". Following the seminal work of O'Neill (1982), a vast literature focused on the axiomatic analysis of bankruptcy problems. The axiomatic literature provided a large variety of bankruptcy rules as solutions to these problems. Here, I focus on two of the most popular of these principles: proportionality (PRO), and equal losses (EL). As their names suggest, these principles suggest that the agents' shares should be chosen, respectively, (i) proportional to their investments, (ii) so as to equate their losses from initial investment. These rules are also commonly used in law partnerships as the two most common negative surplus sharing methods in real life (Farrell and Scotchmer, 1988; Lang and Gordon, 1995).

I model individuals' rule choice and investment behavior through the following sequential game in the paper: There are two individuals and each of them first chooses which rule to select in the case of bankruptcy, EL or PRO by knowing one of the investor's rule choice is implemented. Then with the knowledge of which rule is chosen, they choose their investment levels. The sum of investment levels forms the value of the firm. This value can increase with some probability or decrease (bankruptcy situation) with the remaining probability. If the firm's value increases then investors get a higher share that is proportional to their initial investment levels.[1]

If the value of the firm decreases, one of the investors' rule choices is implemented. In particular, if EL is implemented, each investor gets her initial investment back, after the half of the loss in the project's value is subtracted. If PRO is implemented, each investor gets a share from the shrunk firm's value that is proportional to her initial investment.

For this sequential game, it is expected for risk neutral agents to (i) invest all of their endowment both under PRO and EL, if the expected gain of investing is

[1] Here, I fix the rule used for sharing the gain to PRO and focus on allowing individuals to choose between two rules to share the loss. There are two reasons of doing that: 1) One of the rules that is commonly used for sharing gain (Equal Awards, EA, which gives equal shares to investors) gives free-riding incentives to agents. By assuming that, individuals who are trying to increase the group's investment will not choose that rule when they are allowed to choose between PRO and EA. 2) Having rule choices for both gain and loss scenarios would make the experiment more complicated, i.e., subjects would have difficulty in understanding the procedures in that case.

higher than the expected gain of not investing, (ii) not to invest anything both under PRO and EL if the expected gain of investing is lower than the expected gain of not investing. Further, (iii) when agents are assumed to invest the same amount under EL and PRO in the sub-game, and believe that other group members invest as much as they do due to symmetry in agents' risk aversion and wealth levels, they are indifferent between EL and PRO.[2]

Understanding the rule selection and its implications into the investment in controlled experiments will provide us how individuals choose sharing rules for their losses and how these choices affect their investments afterwards in a way that is not previously considered in the axiomatic literature, in the partnership literature, or in the experimental literature. To this end, I use a simple experiment. First, subjects are informed that one of the bankruptcy rules chosen by them or their group member is implemented in the case of bankruptcy: PRO or EL. With a strategy method,[3] I elicit how 2 subjects contribute their endowments into a group project under PRO and EL. Afterwards; they are asked which rule they want to be implemented for their group project in the case of bankruptcy. Then, again with a strategy method,[4] each agent is asked to guess the group's average contribution under PRO and EL. In order to determine the realized bankruptcy rule, a random number is drawn. If it is high, the first agent's bankruptcy rule choice is implemented and if it is low, the second agent's bankruptcy rule choice is implemented. The sum of group members' investments under "the implemented bankruptcy rule" determines the value of the firm. The firm is a lottery, which either brings a positive return (with probability $p$) or goes bankrupt (with probability $1-p$). In the former case, the firm distributes dividends with an interest. In the latter case, that is bankruptcy, its liquidation value is allocated among the investors according to the implemented bankruptcy rule. I also incentivize the beliefs. Agents are paid in proportion to the precision of their guesses under the implemented bankruptcy rule.

Three main insights emerge from the experiments. First, subjects' risk aversion levels do not affect their investment choices. However, subjects do not choose their investment levels according to the predictions for risk-neutral agents. In particular, when the expected gain of investing is higher than the expected gain of not investing, subjects invest significantly lower than their endowment and when the expected gain of investing is lower than the expected gain of not investing, subjects invest significantly more than 0. Second, they expect their group members

[2] If an agent believes that her investment to the group project is higher than the group's average investment, she prefers EL to PRO.

[3] In the strategy method a responder makes conditional decisions for each possible information set in the game.

to invest as much as they do on average. Further, they are indifferent between the rules. Third, EL and

PRO induce similar investment levels under both rules.

This paper is closely related to Kıbrıs and Kıbrıs (2013), Karagözoğlu (2014) and Büyükboyacı et al. (2016). First two are game theoretic papers that analyze investment implications of a class of bankruptcy rules via noncooperative investment games. The model used in this paper, assumes that agents are risk neutral whereas Kıbrıs and Kıbrıs (2013), assume that agents are risk averse. The model in this paper also assumes that agents are homogenous in terms of wealth levels whereas Karagözoğlu (2014) assumes that there are two types of agents who are differentiated by their incomes. Moreover, I assume that investors can choose the bankruptcy rule. Karagözoğlu (2014) also assumes an endogeneity for bankruptcy-rule selection but in his case a company management chooses the bankruptcy rule to maximize his profit. There is no rule selection part in Kıbrıs and Kıbrıs (2013): agents play an investment game under a pre-specified bankruptcy rule. The last paper is an experimental paper, which analyzes investment implications of exogenously determined rules, i.e., tests the predictions made in Kıbrıs and Kıbrıs (2013). The main difference between this paper and Büyükboyacı et al. (2016) is the endogeneity of the rules. While they find that EL brings higher investment than PRO when the success rate is low, in this paper, when the rules are chosen endogenously I find no difference in investment levels elicited by these rules under both success rates. Further, while they find that subjects' risk aversion levels affect their investments, this paper finds no effect of risk aversion on the investments.

Other than Büyükboyacı et al. (2016), the following two experimental papers studied the bankruptcy rules. Gaechter and Riedl (2005) study an environment where the subjects bargain over a resource that falls short of the sum of their claims (as in typical bankruptcy) and inquires which of the three main principles (proportionality, equal awards[5], equal losses) is a better predictor of behavior. In their experiment, subjects share the remaining endowment after bankruptcy and they propose a division for others. They find that while the subjects demand shares consistent with the equal awards principle, they offer shares to others that are consistent with the proportional principle. In the second study, Herrero et al. (2010) ask each subject to choose a bankruptcy rule. If the majority chooses the same rule with the agent that rule is implemented as the bankruptcy rule, otherwise she is fined a small amount. They find that subjects coordinate on choosing the proportional rule. In their paper, a bankruptcy rule choice exists but instead of understanding agents' preferences for the rules, their game focuses on the

[5] According to equal awards, the agents' shares should be chosen, to equate their awarded shares.

coordination incentives. To my knowledge, there is no study, exploring the investment implications of endogenously determined bankruptcy rules or trying to understand agents' preferences for allocation rules while sharing losses.

The paper is organized as follows. Section 2, provides the basic theoretical background. Section 3 describes the experimental design. Section 4 and 5 present experimental results for bankruptcy-rule choice and investment levels, respectively. Section 6 concludes and discusses the results.

## 2. Theory

To motivate the experiment, I summarize the related theoretical findings in this section.

It is a 2-period sequential game. There are 2 risk neutral investors, $u_i(x) = x$ where $i = 1, 2$. In the first period, by knowing one of the investors' rule-choice is implemented in the second period, each investor chooses between EL and PRO. At the beginning of the second period, each investor learns which rule is implemented in the case of bankruptcy. Each investor $i$ invests $s_i \in R_+$ units of wealth on a risky company. The company has value $s_1 + s_2$ after investments. With success probability $p \in (0,1)$, this value brings a return $r \in (0,1]$ and becomes $(1 + r)(s_1 + s_2)$. In this case, each investor *i* receives a dividend of $(1 + r)s_i$. With the remaining probability $(1 - p)$, the company goes bankrupt and its value becomes $\beta(s_1 + s_2)$ where $\beta \in (0,1)$ is the fraction that survives bankruptcy. This amount is allocated among the investors according to the chosen bankruptcy rule. These rules can be Proportional Rule (PRO) or Equal Losses rule (EL). The Proportional Rule (PRO) is defined as follows: for each investor *i*, $PRO_i(s_i) = \beta s_i$ where *i=1, 2*. The Equal Losses rule (EL) is, on the other hand, defined as $EL_i(s_1, s_2) = s_i - \frac{s_1+s_2}{2}$ where *i=1, 2*. If it is assumed that an individual invests the same amount, $s_i$ under PRO and EL, expected utilities of risk-neutral agents under these rules will be:

$$EU_i^{PRO}(s_i) = prs_i + (1 - p)\beta s_i$$

$$EU_i^{EL}(s_i) = prs_i + (1 - p)\left(s_i - \frac{1 - \beta}{2}(s_1 + s_2)\right)$$

If all agents are symmetric, i.e., all invest the same amount in equilibrium, then these rules will bring the same expected utility to an agent in the sub-game. Hence, in the first period, if an agent thinks that other agents invest as much as she does and if she chooses the same amount to invest under both rules then she will be indifferent between EL and PRO. Since the utilities are linear, due to risk neutrality

assumption, an agent should invest all of her investment if $pr > (1-p)(1-\beta)$ and invest nothing if $pr < (1-p)(1-\beta)$. Hence, if agents are risk-neutral, for a given set of parameters they will either invest all of their endowments or invest nothing in the sub-game. If an agent expects that she invests more (less) than the group average, i.e., if an agent thinks that symmetry among the players is not satisfied, then she prefers EL (PRO) rule to PRO (EL) rule.

The experiment is designed to address the following hypotheses based on the theoretical part of the paper:

**Hypothesis 1:** If $pr > (1-p)(1-\beta)$, risk-neutral subjects invest all of their investment under both rules.[6]

**Hypothesis 2**: If $pr < (1-p)(1-\beta)$, risk-neutral subjects invest nothing under both rules.[7]

**Hypothesis 3**: If a subject believes that she contributes more (less) than the group average, she prefers EL (PRO) to PRO (EL).

## 3. Experimental design and procedures

The experiment was designed to address the three hypotheses listed in Section 2. It had two stages.

In the first stage, I elicited the risk attitude of each subject by Holt and Laury's (2002) method. According to this method, subjects must choose one of two lotteries available for ten different situations (Figure 1 in Appendix A). In Situation 1, the less-risky lottery (Option A) has a higher expected payoff than the more-risky one (Option B). Hence, only very strong risk lovers pick Option B in this situation. Moving further down the table in Figure 2, the expected payoff difference between the lotteries in Option A and in Option B decreases and eventually turns negative in Situation 5. In Situation 10, all subjects must choose between a sure payoff of 400 token (Option A) and a sure payoff of 770 token (Option B). Since all rational individuals prefer the latter one in the last situation, by then all subjects should have switched from Option A to Option B. In this experiment, 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 the experiment, I asked subjects when they wanted to switch from Option A to Option B in the experiment. With these payoffs, it is optimal for a risk-neutral subject to switch from Option A to Option B in Situation 5. Similarly, it is optimal for a risk-averse (risk-loving) subject to switch from Option A to Option B after (before) Situation

[6] $EU_i(s_i) = p\big((1+r)s_i - s_i\big) + (1-p)(\beta-1)s_i > 0.$

[7] $EU_i(s_i) = p\big((1+r)s_i - s_i\big) + (1-p)(\beta-1)s_i < 0.$

5. The payment for this stage was determined according to a randomly chosen row among these ten situations and the subject's lottery choice in that particular row.

In the second stage, I implemented 2x2 design. Namely, I varied the bankruptcy rule EL or PRO and the success rate $p = 0.3$ or $p = 0.6$.[8] In all treatments, I kept the fraction that survives bankruptcy ($b = 0.4$) and the return rate in the case of project is successful ($r = 1$), identical. Bankruptcy rules were changed within session (I elicited subjects' investment decisions with a strategy method without letting subjects know which rule would be implemented ex-ante.) the success rate treatments were run by using between-subject design.

There were eight sessions: four sessions of the high success-rate and four sessions of the low success-rate treatments. In the second stage of this treatment, each subject went through the following steps. First, subjects were informed that they would play 12 identical rounds.[9] They were randomly and anonymously matched into pairs for each round and formed a group. Then, subjects were explained the format of the game they would play in this stage. Subjects were only told that if the project value decreased to 40% of the original value, they could choose between Rule 1 (PRO, explained through Figure 2 in Appendix A) and Rule 2 (EL, explained through Figure 3 in Appendix A) and either their or their teammate's choice would be implemented in the case of bankruptcy. In particular, first, they were asked how many of their tokens they want to contribute on the group project if Rule 1 (PRO) were to be implemented to share the loss and how many of their tokens they want to contribute on the group project if Rule 2 (EL) were to be implemented to share the loss.[10] Then, they were asked which rule they want to have as a bankruptcy rule for the game in their group. Then, they were asked their beliefs about the average contribution of the group under Rule 1 and Rule 2, respectively.[11]

Their payoffs from this stage were determined as follows: First a random number determined which group member's rule choice would be implemented. Then, both group members' contribution levels and beliefs about the group's average contribution under the implemented bankruptcy rule determined their payoffs.

Suppose group member 1 chose EL and group member 2 chose PRO. Each group member also entered the number of her tokens she would like to contribute

---

[8] I chose the parameter set, $\{p = 0.6, r = 1, b = 0.4\}$ to make subjects to have positive expected payoff, i.e., in order to check the prediction in Hypothesis 1. Further, I chose the parameter set, $\{p = 0.3, r = 1, b = 0.4\}$ to make subjects to have negative expected payoff, i.e., in order to check the prediction in Hypothesis 2.

[9] For the second stage of this treatment, subjects were paid only for one period (among 12), to avoid potential wealth effect.

[10] For each rule implementation, they were told that they have 400 tokens.

[11] Questions that were asked with strategy method were asked in the same screen to avoid order effect.

and her expectation about the group's average contribution under both rules. Suppose, according to the random number, group member 1's rule choice was implemented. Then, subjects' contributions under EL were used to calculate their payoffs for the investment part and subjects' beliefs under EL were used to calculate their payoffs for the belief part. The payoffs for the investment part were determined as follows: A random number was drawn and if this number was smaller than 0.3 or 0.6 (depending on the treatment) the project value was doubled and each group member obtained twice as much as her contribution to the group project. If the random number was greater than 0.3 or 0.6 (depending on the treatment) the project value shrank to 40% of the original value and each subject got the difference between her contribution and the half of the loss in the project's value (since implemented rule is EL).

The payoffs for the belief part were determined as follows: If the difference between a subject's belief about the group's average contribution and the group's actual average contribution under EL, was less or equal to 10, subjects were paid 400+400 tokens; if this difference was more than 10, subjects were paid 400+400/difference.[12] So, the closer the difference was, the higher payoff a subject obtained for the belief part. For beliefs, subjects were incentivized with a method that is similar to the one used by Gaechter and Renner (2010). Another random number determined whether the subjects' payoffs for the second stage were according to the investment game or how accurate their beliefs were. After explaining the game and the rules, participants took a quiz (non-incentivized) to confirm their understanding of the experimental procedures. The experiment did not proceed until all subjects understood the procedures.

In all sessions, after each round, subjects saw a feedback screen where, subjects were informed about which rule was implemented in the case of bankruptcy, their own and other team members' contributions under the implemented rule, their guesses about the group's average contribution under the implemented rule, whether the value of group project increased or decreased, whether their earnings at that period stemmed from investment or belief, and their earnings at that round.

In total, 88 subjects participated into the experiment. At the beginning of each session, participants were divided into matching groups of 4, in order to avoid dependencies between all observations of one session.[13] In a given round, the subjects interacted in pairs. The order of matching groups was also randomly determined in the experiment. This procedure was not explicitly stated in the

[12] Fixed 400 tokens were given in the belief part to equate possible maximum earnings in investment and belief parts.

[13] Independent observations from a session come from these matching groups that are composed of 4 subjects.

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 would likely be different at each round.

In the instructions, a neutral language was used: The members of a group corresponded to investors of the firm, the project value corresponded to the firm, an increase in the project value corresponded to success of a firm, a decrease in the project value corresponded to bankruptcy of a firm, sharing scheme when the project value decreases corresponded to bankruptcy rule, contribution to the team project corresponded investment into the firm.

Subjects were recruited by using posters hanged around the campus. The participants were undergraduate students at the Middle East Technical University. The experiment was computerized using z-tree (Fischbacher, 2007). A subject earned 21.7 TL on average, including the participation fee.

## 4. Rule choice

In this section, I first check how beliefs and investments change with high and low success rates. In Table 1, I summarize the mean individual investment levels and the beliefs for average group investments under the EL and PRO rules with high and low success rates. The part of the table related to beliefs suggests that, on average, subjects predict average group investment to be higher under PRO than under EL when the success rate is low and high. However, Mann-Whitney tests suggest that, this difference in beliefs is not significant when the success rate is low ($p = 0.11, n = 11$) and when the success rate is high ($p = 0.16, n = 11$). For a given rule and success rate, when I compare the investments and beliefs about group's average investment, I observe that investments are slightly higher than the beliefs. However, these differences are not significant according to Mann-Whitney tests. In particular, Mann-Whitney test suggests that investments and beliefs are not significantly different under PRO with high success-rate ($p = 0.16, n = 11$), under PRO with low success-rate ($p = 0.33, n = 11$), under EL with high success-rate ($p = 0.93, n = 11$), and under EL with low success-rate (p=1.00, n=11).

**Table 1**
Mean and Standard Deviation for Beliefs and Investments

| | Success Rates/Rules | EL | PRO |
|---|---|---|---|
| Investment | Low success rate (p=0.3) | 203.1 (138.4) | 224.2(134.3) |
| | High success rate (p=0.6) | 235.1(121.7) | 257.4(119.9) |
| Belief | Low success rate (p=0.3) | 201.4(97.5) | 218.2(96.8) |
| | High success rate (p=0.6) | 234.8(94.0) | 249.6(92.5) |

Having individuals to invest similar amounts under both rules and expecting others to invest as much as they do in the theoretical predictions, suggest that individuals should be indifferent between the rules. When I look at the aggregate data, I observe that subjects choose EL to be implemented as the bankruptcy rule 47% of the time, which is not significantly different from 50%. So, on the aggregate level, subjects' choices are in line with their beliefs. When I look at the data at the individual level, I observe that subjects choose the bankruptcy rule that maximizes their expected payoff 64% of the time when the success rate is high, 57% of the time when the success rate is low. That implies at the individual level, subjects' choices are not in line with their beliefs.

Finally, I check what affects a subject's likelihood of choosing EL as the bankruptcy rule. To this end, I coded the dependent variable as a bivariate one, which takes the value 1 if a subject chooses EL as the bankruptcy rule in a given round and 0 if she chooses PRO. The independent variables were the success rate, gender, level of risk aversion which is measured by subjects' first stage decision,[14] the number of prior rounds in which she played the game, and the difference between a subject's expected payoffs under PRO and EL where I used subjects' beliefs about the groups' average investments to calculate them. Then I ran random effects probit regression analysis in which I accounted for unobserved subject level factors with random effects. The results are presented in Table 2.

[14] Subjects' average switching point in the first stage was 6.41 with standard deviation 1.70, i.e., subjects were risk averse on average.

**Table 2**
Results on EL Rule Choices

| Results of Random Effect Probit Regression<br>Dependent Variable: EL rule choice | |
|---|---|
| Independent Variables | #Subjects: 88<br>#Observations: 1056 |
| Success rate Indicator (High=1,Low=0) | 0.09 (0.16) |
| First stage decision (from 1 to 10) | 0.05 (0.05) |
| Gender Indicator (Male=1, Female=0) | -0.20 (0.16) |
| Experience with the Game | -0.01 (0.01) |
| Difference in Expected Payoffs between PRO and EL | -0.01***(0.002) |
| Constant | -0.30 (0.35) |

Robust standard errors are in the parentheses. Robust standard errors are clustered at the subject level.
***=statistically significant at 1% level

Among all independent variables, only I observe the difference in expected payoffs between PRO and EL affects the probability of choosing EL as the bankruptcy rule. That implies, subjects make their rule choices in line their beliefs.

## 5. Investment

According to the part of Table 1 that is related to investments suggests that, on average, subjects invest more under PRO than under EL when the success rate is high or low. However, Mann-Whitney tests suggest that, this difference in investments is not significant when the success rate is low ($p = 0.29, n = 11$) and when the success rate is high ($p = 0.18, n = 11$).[15] It is expected from a risk-neutral subject to contribute nothing when the success-rate is low and contribute all of her endowment when the success-rate is high. As can be seen from Table 1, subjects contribute significantly higher than 0 under both EL and PRO when the success-rate is low; subjects contribute significantly lower than 400 (which was each subject's endowment level) under both EL and PRO when the success-rate is high.

I model individual investment as a linear function of the bankruptcy rule, the success rate, as well as a subject's personal characteristics such as gender, level of risk aversion which is measured by subjects' first stage decision, and number of prior rounds in which she played with the same bankruptcy rule. I ran a linear regression by clustering standard errors at the subject level. The results are presented in Table 3.

[15] In Büyükboyacı et al. (2016), where the rules are determined exogenously, subjects invests more under EL than PRO when the success rate is low.

**Table 3**
Results on Investment Choices

| Results of Linear Regression<br>Dependent Variable: Contribution to the Investment Game | |
|---|---|
| Independent Variables | #Subjects: 88<br>#Observations: 1056 |
| Bankruptcy Rule Indicator (EL=1, PRO=0) | 14.26 (15.00) |
| Success rate Indicator (High=1,Low=0) | 35.48* (18.60) |
| First stage decision (from 1 to 10) | -2.47 (4.49) |
| Gender Indicator (Male=1, Female=0) | -2.94 (17.94) |
| Experience with the Game | 2.93** (1.17) |
| Constant | 212.14*** (30.40) |

Robust standard errors are in the parentheses. Robust standard errors are clustered at the subject level.
***=statistically significant at 1% level

Table 3 suggests no significant effect of bankruptcy rule, risk aversion or gender on the investment levels. However, Table 3 suggests that an increase in the probability of success and experience with the bankruptcy rule increase individual investment.

## 6. Conclusion

I report results from experiments that check subjects' rule choices while sharing negative surplus (bankruptcy situation) between two alternative rules, EL and PRO when the success rate is high or low. The findings do not support the first two hypotheses stated in Section 2. A possible explanation for deviation from equilibrium predictions in Hypotheses 1 and 2 can be the mistakes made by risk-neutral subjects when the predicted levels are at the boundaries. The problem of boundary equilibrium predictions has been well recognized in dictator games (List, 2007) and linear public good games (Laury and Holt, 2008), it has been proposed as an explanation for excessive giving and over contribution to public goods.[16]

The analysis supports Hypothesis 3, which stated that subjects' rule choices are in line with their beliefs about the groups' average investment levels. In particular, I find that subjects expect other group members to invest as much as they

[16] I expect subjects to contribute either 0 (in low success rate situation) or 400 (in high success rate situation), i.e., theoretical predictions are at the boundaries. Similarly, dictator game predicts 0 giving to other, and in public good contribution games we expect 0 contribution, and we observe contribution to be higher than 0 in either games in many experiments.

do under both rules, and they invest similar amounts under EL and PRO. Hence, they chose EL and PRO with the same frequency.

Although Büyükboyacı et al. (2016), found that when the success rate is low, investment levels are higher under EL than under PRO when the rules are determined exogenously; I do not see this difference when the rules are determined endogenously. One possible explanation for this result may be strategy method (Brandts and Charness, 2000). Potential reasons of this observation should be explored with further research.

## Appendix

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 these 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 with 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 learn about these parts right before they start. Your aim in both parts is to earn as much money as possible. At the end of the experiment, you will learn about your total earnings from each part.

Your earnings will be in tokens. 100 tokens = 1 TL. Your total earnings will be rounded to the nearest 25 kurus. In addition to your earnings in the experiment, you will be paid a 5 TL participation fee.

### PART 1

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

**Figure 1**
Holt-Laury Instrument in Part 1

| | OPTION A | | | | | OPTION B | | | |
|---|---|---|---|---|---|---|---|---|---|
| Situation | Prob. | Payoff | Prob. | Payoff | | Prob. | Payoff | Prob. | Payoff |
| 1 | 1/10 | 400 | 9/10 | 320 | | 1/10 | 770 | 9/10 | 20 |
| 2 | 2/10 | 400 | 8/10 | 320 | | 2/10 | 770 | 8/10 | 20 |
| 3 | 3/10 | 400 | 7/10 | 320 | | 3/10 | 770 | 7/10 | 20 |
| 4 | 4/10 | 400 | 6/10 | 320 | | 4/10 | 770 | 6/10 | 20 |
| 5 | 5/10 | 400 | 5/10 | 320 | | 5/10 | 770 | 5/10 | 20 |
| 6 | 6/10 | 400 | 4/10 | 320 | | 6/10 | 770 | 4/10 | 20 |
| 7 | 7/10 | 400 | 3/10 | 320 | | 7/10 | 770 | 3/10 | 20 |
| 8 | 8/10 | 400 | 2/10 | 320 | | 8/10 | 770 | 2/10 | 20 |
| 9 | 9/10 | 400 | 1/10 | 320 | | 9/10 | 770 | 1/10 | 20 |
| 10 | 1 | 400 | 0 | 320 | | 1 | 770 | 0 | 20 |

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 situation. These options are basically lotteries that indicate your chances of winning a certain payoff. For each row, you will be asked to choose one among Option A and Option B. If you choose Option B for one row, you will have to choose this option for the remaining rows.

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.

## PART 2

This stage will consist of 12 periods. At the beginning of each period, you will be matched with another subject randomly and you will form a team with him/her. Your teammate will change in every period. The identity of your teammate will not be revealed to you at any time. Your earning from a randomly drawn period among 12 will be your earning for this stage. Your earning in a period may stem from your investment decision for the project or your estimation for the group's average-investment. We will first explain to you how you can earn with your investment decision to the project. For the investment decision part you will play the following game.

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.

Similarly, your teammate will be given 400 tokens as his/her endowment. Then, he/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 his/her private account. Both your contribution and your teammates' contribution can be any number between 0 and 400.

The contribution choices of you and your teammate to the team project will determine the value of the project. In particular, the sum of your contributions will be the value of the project. Then, we will randomize a number between 1 and 10.

If it is lower or equal 6 (occurring with probability 6/10):

- The value of the project doubles.

If it is higher than 6:

The value of the project shrinks to 40% of its original value.

If the value of the project doubles:

- Period earnings for each group member will be 2 times her contribution to the project plus the tokens he keeps in her private account.

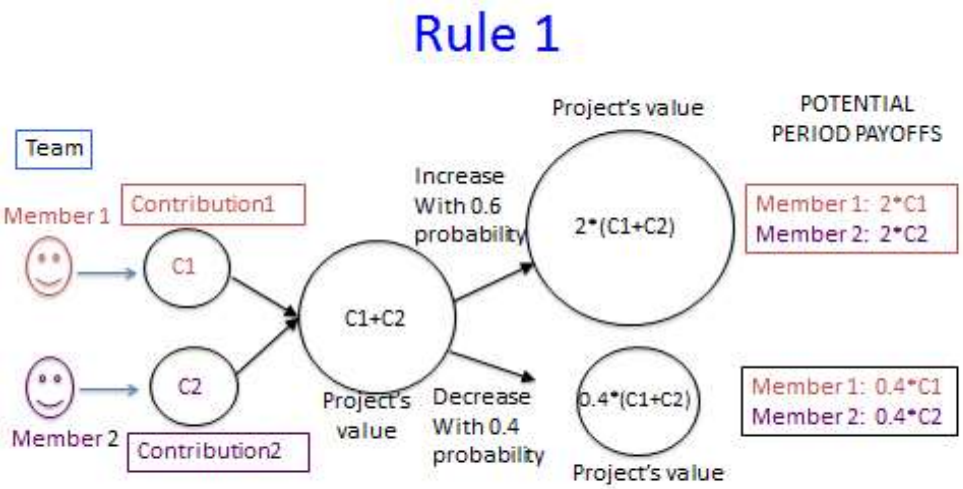
If the value of the project shrinks to 40% of its original value:

- The sharing rule will be determined according to your and the other team member's rule choice.

You and the other team member can choose one of the following rules:

- Rule 1 (Figure 2): Period earnings for each group member will be the tokens she keeps in her private account + her contribution to the Project*0.4.
- Rule 2 (Figure 3) : Period earnings for each group member will be the tokens she keeps in her private account + her contribution to the project minus half of the total loss (0.3 * total contributions).

**Figure 2**
Overview of Rule 1

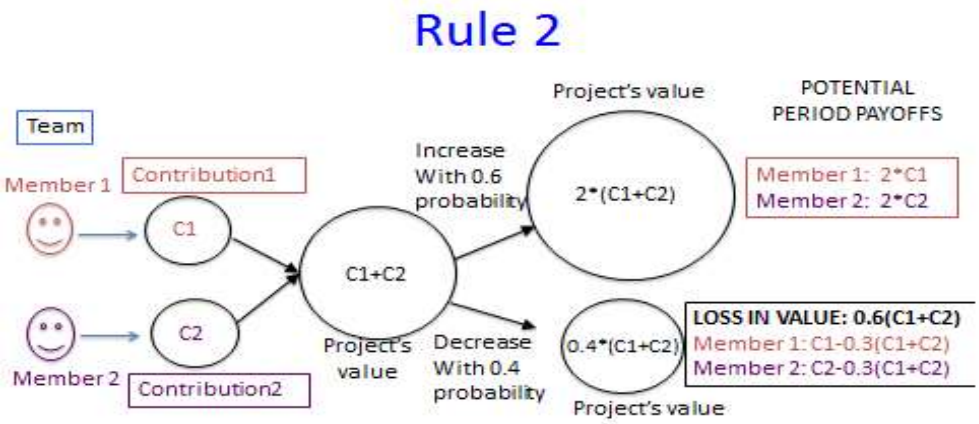



When the value of the project shrinks, the rule you or your teammate chose will be used for sharing the remaining value of the project.

In each period, you will make the following decisions without knowing which rule is used when the value of the project shrinks: How many of your tokens, do you want to contribute to the project under two potential rules? Which rule do you want to be used for sharing, when the value of the project shrinks? Could you estimate what your group's average contribution is under two potential rules?

The computer will determine which rule will be used when the value of the project shrinks after both you and your teammate make your choices.

**Figure 3**
Overview of Rule 2




You and your teammate can make earning through your estimation as follows:

- If the difference between your estimation about group's average contribution and actual group's average contribution under the implemented rule is:
    - 10 or less than 10, you will win 400+400 tokens.
    - More than 10, you will win 400+400/difference.

Lastly, the computer will determine whether your period earnings come from your investment decision or your estimation by drawing a number between 0 and 1. If this number is below or equal to 0.5, your period earning comes from your investment decision, otherwise it comes from your estimation.

After you and your teammate enter your contributions and your estimations for group's average contributions under both rules and which rule you would like to choose when the value of the project shrinks, you will observe the following on the screen:

- Which rule is implemented.
- Both your and your teammates' contribution levels under the implemented rule.
- Your estimation about group's average contribution under the implemented rule.
- Whether the value of team project increased or decreased.
- Your earnings for that period stems from investment decision or estimation.
- Your earnings for that period.

Then you will be randomly matched with someone and move on to the next period.
*Example 1*:

- Suppose you contributed 120 of your 400 tokens under Rule 1, 150 of your 400 tokens under Rule 2. You wanted a sharing according to Rule 1 when the value of the project shrinks. You estimated group average contribution to be 150 under Rule 1 and 180 under Rule 2.
- Suppose your teammate contributed 180 of his/her 400 tokens under Rule 1, 120 of his/her 400 tokens under Rule 2. S/he wanted a sharing according to Rule 1 when the value of the project shrinks. S/he estimated group average contribution to be 130 under Rule 1 and 130 under Rule 2.
- Payoffs from the investment decisions: Since both team members chose Rule 1, we will take into account the investment decisions of both members under Rule 1. You contributed 120 of your 400 tokens and your teammate contributed 180 of his/her 400 tokens under Rule 1. The value of the project is 120+180=300. Then a random number from 0 to 1 is selected and it comes out as 0.8 (higher than 0.6). The value of project becomes 300*0.4=120. Since Rule 1 suggests the value of shrank project should be divided between team members proportional with their contributions to the project, you earned 280 (what remained in your private account)+120*0.4 (what you earned from the Project)=328, other team member 220 (what remained in his/her private account)+180*0.4 (what s/he earned from the Project)=292.
- Payoffs from the estimations: You estimated the group's average contribution under Rule 1 to be 150 and it became 150 actually. Since the difference between your estimation and actual value is less than 10, you earned 400 token with your estimation. Your earnings from the period is 800 tokens. Your teammate estimated the group's average contribution under Rule 1 to be 130 and it became 150 actually. Since the difference between his/her estimation and actual value is 20 (more than 10), s/he earned 400/20 token with his/her estimation. His/her earnings from the period is 420 tokens.
- Lastly, to determine whether your and your teammate's period earnings are according to your investment decision or your estimation, the computer draws a number between 0 and 1, 0.45 came out. Hence your period earnings are determined according to your investment decisions, i.e., you earned 328 tokens and your teammate earned token.

# References

BRANDTS, J. and CHARNESS, G. (2000), "Hot vs. cold: Sequential Responses and Preference Stability in Experimental Games", *Experimental Economics*, 2, 227-238.

BÜYÜKBOYACI, M., GÜRDAL, M.Y., KIBRIS, A., and KIBRIS, Ö. (2016), "An Experimental Study of the Investment Implications of Bankruptcy Laws", http://www.econ.boun.edu.tr/gurdal/bankruptcy.pdf.

FARRELL, J., and SCOTCHMER, S. (1988), "Partnerships", *Quarterly Journal of Economics*, 103(2), 279-297.

FISCHBACHER, U. (2007), "Z-Tree: Zurich Toolbox for Ready-Made Economic Experiments", *Experimental Economics*, 10, 171-178.

GAECHTER, S., and RIEDL, A. (2005), "Moral Property Rights in Bargaining with Infeasible Claims", *Management Science*, 51 (2), 249-263.

GAECHTER, S., and RENNER, E. (2010), "The Effects of (Incentivized) Belief Elicitation in Public Good Experiments", *Experimental Economics*, 13 (3), 571-594.

HERRERO, C., MORENO-TERNERO, J. D., and PONTI, G. (2010), "On the Adjudication of Conflicting Claims: An Experimental Study", *Social Choice and Welfare*, 34(1), 145-179.

HOLT, C., and LAURY, S. (2002), "Risk Aversion and Incentive Effects", *The American Economic Review*, 92, 1644-1655.

KARAGÖZOĞLU, E. (2014), "A Noncooperative Approach to Bankruptcy Problems with an Endogenous Estate", *Annals of Operations Research*, 217(1), 299-318.

KIBRIS, Ö., and KIBRIS, A. (2013), "On the Investment Implications of Bankruptcy Laws", *Games and Economic Behavior*, 80, 85-99.

KIBRIS, Ö., and KIBRIS, A. (2016), "On Surplus Sharing", *Social Choice and Welfare*, forthcoming.

LANG, K., and GORDON, P.J. (1995), "Partnership as Insurance Devices: Theory and Evidence", *RAND Journal of Economics*, 26(4), 614-629.

LAURY, S.K., HOLT, C.A. (2008), "Voluntary Provision of Public Goods: Experimental Results with Interior Nash Equilibria", In: Plott, C.R., Smith, V.L. (Eds.), *Handbook of Experimental Economics Results*, vol. 1. Elsevier, New York, 792-801.

LIST, J.A. (2007), "On the Interpretation of Giving in Dictator Games", *Journal of Political Economy*, 115 (3), 482-493.

O'NEILL, B. (1982), "A Problem of Rights Arbitration from the Talmud", *Mathematical Social Sciences*, 2, 345-371.

# Özet

## Ortaklıklarda zarar paylaşımı

Bu çalışmada kişilerin, paylaşım için teorik literatür tarafından önerilmiş iki kuraldan, eşit kayıp ve orantısal kural, hangisini tercih ettiklerini bir deney aracılığı ile anlamaya çalıştık. Deneyde kişilere bir yatırım oyununda grup projesine ne kadar katkıda bulunabileceklerini sorduk. Gruptaki iki kişinin yatırımları toplamı projenin değerini belirledi. Bu değer belli bir ihtimalle büyürken (başarı) belli bir ihtimalle küçüldü (iflas). Projenin büyümesi durumunda kişiler, başlangıçtaki yatırımları ile orantılı bir şekilde kazanç sağladılar. İflas durumunda ise, küçülen proje değerini paylaşmak için eşit kayıp ya da orantısal kuraldan birini seçtiler. Bu oyunda kişilerin risk tercihi açısından simetrik olduğu düşünüldüğünde risk nötral bir kişinin iki kural altında aynı umulan faydayı sağladığı görülebilir. Dolayısıyla kişinin bu iki kural arasında seçim yaparken kayıtsız olması beklenir. Buna karşın, kişi grubun ortalama yatırımı ile ilgili beklentisi ile kendi yatırımı arasındaki farka bağlı olarak, bir kuralı diğerine tercih edebilir. Bu çalışmada öncelikle kişilerin kural seçimlerinin, projenin başarılı olma ihtimali, kişilerin umulan faydalarına (bu faydalar, kişilerin ortalama grup yatırımı ile ilgili inançları ile bulunmuştur.) ek olarak, risk tercihi ve cinsiyet gibi kişisel özelliklerinden nasıl etkilendiğini anlamaya çalıştık. Sonuçlara göre kişilerin diğer grup üyelerinin de kendisi kadar yatırım yapacaklarını umduklarını ve iki kuralı benzer oranlarda tercih ettiklerini gözlemledik. Ayrıca iki kuralın benzer grup yatırımına sebep olduğunu ve kişilerin yatırımlarının kişilerin risk tercihlerinden etkilenmediğini gözlemledik.



*Anahtar kelimeler:* İflas, işbirliksiz yatırım oyunu, orantısal, eşit kayıp, endojen kural seçimi, ortaklık, deney.

*JEL kodları:* C72, C91, D78, G33.