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THE EFFECT OF INDIVIDUAL WEALTH ON INVESTMENT DECISIONS UNDER DIFFERENT BANKRUPTCY RULES: AN EXPERIMENTAL STUDY

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The Effect of Individual Wealth on Investment Decisions under Different Bankruptcy Rules: An Experimental Study

Bireysel Servetlerin Farklı İflas Kuralları Altında Yatırım Kararlarına Etkisi: Deneysel Bir Çalışma

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ABSTRACT

In this thesis, we theoretically and experimentally analyze the effect of the wealth levels and underlying bankruptcy rules on investment decisions in a bankruptcy game setting. Chapter 1 constructs a bankruptcy model using DARA (Decreasing Absolute Risk Aversion) as investors' utility function to examine the wealth effect on investment. This utility function assumption includes the uninvested portion of the wealth in the utility equation and leads to an intuitive equilibrium behaviour. Using Nash Equilibrium as the solution concept, investment levels become observable under different rules and parameters. The three division rules focused on this thesis are Proportionality (PRO), Equal Awards (EA), and Equal Losses (EL). These rules are examined separately and as combinations to see which rule(s) leads to higher total investment levels. The analysis results show that an agent's equilibrium investment is affected by her own wealth and the wealth of the other agents. There is a two-agents case for computational and illustrative purposes in the last part of the chapter to complement the theoretical part. In Chapter 2, a controlled laboratory experiment is conducted to test and analyze the theoretical outcomes achieved in Chapter 1. The theoretical framework refers explicitly to DARA in terms of risk behaviour. A risk elicitation method classified subjects according to their risk aversion classes. Analyses contested the outcomes of Chapter 1 for DARA subjects and all classes included. In order to capture wealth effect and endowment asymmetries, various endowment allocations were assigned under each rule. Predictions formed by the theory are successfully observed in the individual investments under PRO and EA. Both PRO and EL maximize the investments by yielding more investment than EA. However, PRO and EL do not differ significantly.

Keywords: Bankruptcy Principles, Laboratory Experiments, Decreasing Absolute Risk Aversion, Wealth Effect, Investment

ÖZET

Bu çalışmada, bir iflas oyunu ortamında servet seviyelerinin ve iflas kurallarının yatırım kararları üzerindeki etkisi teorik ve deneysel olarak analiz edilmiştir. Bölüm 1'de, yatırımcıların fayda fonksiyonu olarak DARA'yı (Azalan Mutlak Riskten Kaçınma) kullanarak servet etkisini incelememizi sağlayan bir iflas modeli geliştirilmiştir. Bu fayda fonksiyonu kullanımı, kişilerin servetlerinin yatırım yapılmamış kısmını fayda denklemine dahil etmemizi ve sezgisel denge davranışına ulaşmamızı sağlar. Çözüm konsepti olarak Nash Dengesi kullanılarak, yatırım seviyeleri farklı kurallar ve parametreler altında gözden geçirilir. Literatürde yaygın olarak incelenen üç iflas kuralı, yani Orantılılık, Eşit Ödüller ve Eşit Kayıplar üzerinde odaklanılmıştır. Bir ajanın denge yatırımının hem kendi servetinden ve hem de diğer ajanların servetinden etkilendiği gösterilmiştir. Bölüm 1'in son bölümünde teorik bölümü tamamlamak için hesaplama ve örnek amaçlı iki kişi senaryolu bir model vardır. Bölüm 2'de ise Bölüm 1'de elde edilen teorik sonuçları test etmek ve analiz etmek için kontrollü bir laboratuvar deneyi yürütülmüştür. Katılımcıları riskten kaçınma tavrı sınıflarına göre ayırmak için bir risk tavrı tespiti metodu kullanılmıştır. Servet seviyelerinin ve varlık asimetrilerinin etkilerini yakalamak için her bir kural altında çeşitli varlık tahsisleri atanmıştır. Teorinin oluşturduğu çıktılar bireysel yatırım seviyeleri incelendiğinde Orantılılık ve Eşit Ödüller kuralları altında davranışsal destek bulmuştur. Kurallar yatırım seviyesi yönünden karşılaştırıldığında, en yüksek yatırımın Orantılılık ve Eşit Kayıplar kuralları altında sağlandığı, fakat bu iki kuralın kendi aralarında ayrışamadığı gözlemlenmiştir.

Anahtar Kelimeler: İflas Kuralları, Laboratuvar Deneyi, Azalan Mutlak Riskten Kaçınma, Varlık Etkisi, Yatırım

INTRODUCTION

Bankruptcy problems made their debut in the literature in the 1980s. The pioneering study is the work of O'Neill (1982), which examines a story from the Talmud. In the story, a man dies bequeathing a certain amount of estate that needs to be arbitrated between his children. The problem is that the total claims exceed the value of the estate. The large class of such problems, where the asset to be allocated does not fulfill the sum of claims, constitutes the class of bankruptcy problems. A specific example can be a firm where each creditor holds a claim and the total value of the claims exceeds the firm's liquidation value.

Specifying a division rule for bankruptcy is part of setting up institutions. Smith (1989) points out that "institutions matter" on agent incentives, and agent incentives are affected by institutional rules. Also, bankruptcy problems are suitable to be adapted to experimental designs. This adaptability creates a potential for the results of theoretical studies to be tested through controlled laboratory experiments. Testing the validity of the predictions of theoretical models with controlled laboratory experiments is important for the theoretical literature to present better models and to guide policymakers. With the development of the field of experimental economics, its increasing popularity, and the spread of experimental studies, an increase in experimental studies on bankruptcy problems has been observed in recent years. This thesis aims to help to deepen the understanding of the effect of bankruptcy principles on investment decisions. In Chapter 1, there is an non-cooperative model where agents invest in a project together. In Chapter 2, the findings and theoretical predictions of the model in Chapter 1 is tested through a contolled laboratory experiment.

Studies that are mostly related to Chapter 1 of this thesis investigates the effects of specified bankruptcy rules on investment decisions in a strategical frame. Investing in a project or giving a loan to a firm can turn into a bankruptcy problem, which contains a strategical decision-making process. In these scenarios, claims are not exogenous; they are formed endogenously by investors. When a group of people invests in a project, if the value increases, the division will take place according to Proportionality (PRO). When the final value of the project does not meet the total claims, the previously decided bankruptcy rule steps in. In PRO, everyone will receive their money back according to their share in the project. In EL (Equal Losses), the total loss that occurred is divided equally among all participants. In EA (Equal Awards), the remaining value is shared equally between participants. Therefore, EL favors the investor who invests more than the average investment (bigger), and EA favors the one with less investment than the average (smaller). The strategic investment process gets affected by the nature of these rules. Each rule gives different incentives to bigger and smaller investors. The two closely related studies are Kıbrıs and Kıbrıs (2013), Karagözoğlu (2014) that are explaining how these rules create incentives for investors.

We consider a simultaneous moves non-cooperative game of investment, and the underlying solution concept is Nash equilibrium. The agents' wealth level becomes relevant thanks to preference specification and affects their investment decisions. This impact depends on the underlying bankruptcy rule to be implemented; if the investment fails, the remaining value of the assets will be divided among the agents. PRO, EL, EA, and mixture rules of the latter two with PRO weighted by $\alpha \in [0, 1]$, are analyzed in terms of both equilibrium investment and total equilibrium investment. If the agents' wealth levels increase, it turns out that the equilibrium investment also increases.

Our main findings from Chapter 1 are that, first of all, an increase in wealth leads to an increase in investment regardless of the underlying bankruptcy rule to be used. Also, there is another effect that results from the changes in the other people's wealth. This second effect varies with the bankruptcy rules and will be examined in detail throughout the following sections. Finally, similar to Kıbrıs and Kıbrıs

(2013), the ranking of the bankruptcy rules regarding total equilibrium investment is EL>PRO>EA in our model.

One of the earliest experimental studies is Gächter and Riedl (2005). In an experimental setup where the amount of claims is exogenously given, two subjects make a free form bargaining over a bankrupt value. In each group, one member has a greater claim than the other one. Other than free-form bargaining, they ask subjects, as if they were an arbitrator, what should be the division ratio between these two agents. They check whether the results from bargaining and arbitration question match or not. Meanwhile, subjects propose Proportionality as an arbitrator for others; their behavior in the bargaining session is consistent with Equal Awards. Another few experimental studies, as in Gächter and Riedl (2005), focused on the allocation part of the problem, used exogenous claims, and asked which rule is preferred by behavioral evidence.

The closest experimental study to the experiment in Chapter 2 of this thesis, Büyükboyacı, Gürdal, Kıbrıs, and Kıbrıs (2019), bases its model on Kıbrıs and Kıbrıs (2013) and compares amount of total investment in groups under *PRO*, *EL* and *EA*. Their model assumes that people have Constant Absolute Risk Aversion (CARA) preferences, same with Kıbrıs and Kıbrıs (2013). Therefore, agents in the model are not sensitive to wealth. Chosen bankruptcy rule, level of constant absolute risk aversion of the agent, success probability (p) and surviving fraction in case of bankruptcy (β) derives the amount of investment. While they assigned equal endowment to each subject, they managed to find behavioral evidence in line with the results of Kıbrıs and Kıbrıs (2013). Total investment is at its greatest level under EL; it is followed by PRO and EA, respectively.

In strategic investment games, the division rule to be used in the case of bankruptcy may require players to consider ”who” they are with investing with. For instance, U.S.A. bankruptcy law dictates that ”Chapter 7” or ”Chapter 11” should be used to resolve the problem if a company goes bankrupt. Chapter 7 suggests liquidating the company through a court decision, splitting it into secured creditors, unsecured creditors, and shareholders in order of priority. On the other hand, Chapter 11 is the application to reorganize the firm and rearrange its activities in order to get its obligations fulfilled. The action plan has to be accepted by all the creditor groups in order for a Chapter 11 application to be approved. Two-thirds of the total debt holders and the majority within each priority group should approve the plan. In other words, when a company is given a loan or an investment is made, the distribution of shares within the group also has a say in the fate of the company and the income we will obtain in case of bankruptcy. In the strategic decision to be made by considering this situation, the capital of the opponents and how much they can invest are important. There are individuals and companies of different wealth levels in societies. Accordingly, micro and macro effects of the choice of bankruptcy rule on the economy can be foreseen:

* The choice of the bankruptcy rule determines the total investment in capital partnerships that stakeholders of different and same wealth levels will make.

* The choice of bankruptcy rule will affect the stakeholder preference of individuals and companies. This will affect the dynamics of the economy's composition regarding the scale of capital partnerships to be established.

* It is necessary for economic growth for individuals and companies to channel their assets to investment. The bankruptcy rule's choice determines how many of individuals and companies will invest in their assets. Therefore, choosing the bankruptcy rule that best evaluates the investment potential of individual and corporate assets is critical.

Chapter 1 of this thesis shows investors' wealth affects how much they can invest. The model makes wealth relevant and essential to investment decision-making by employing a Decreasing Absolute Risk Aversion (DARA) utility function. This model's risk attitude and utility function assumption allows us to examine situations where people from different asset levels invest in the same project and how one's and others' wealth affects their investment. Also, one's reaction to her own and others' wealth changes becomes reviewable.

In Chapter 2, we conducted an experiment based on Chapter 1's model and hypotheses of the theoretical work. A controlled laboratory experiment is used to examine the effect of bankruptcy rules on investment decisions when subjects are paired with a person having equal, greater, or lower endowments. Investment decisions of the subjects are collected under PRO, EL and EA and elicitated their risk preferences through a dynamic portfolio investment task. Subjects were informed previously about what endowment pairs and which bankruptcy rules will be assigned to them throughout the experiment. At the end of each round, the value of the project is divided between investors proportionally if the value increases; otherwise assigned bankruptcy rule steps in. Under each rule, subjects had four identical rounds; points assigned to the two members were 300-300 in the first round, 300-600 and 600-300 in the following two rounds and 600-600 in the last round. All subjects experience having equal, lower and higher endowment compared to others and face an increase in endowment in the fourth round. Examining how the differences in the wealth levels and different bankruptcy rules affect investment decisions using controlled laboratory experiments is vital in making sense of real-life investment decisions and building better theoretical models. The following predictions rise from the theoretical model:

i. If one's wealth increases, everything else being equal, she reacts to increase her investment, under all bankruptcy rules.

ii. Under Equal Losses, if the wealth of one of the group members increases, the wealthier's investment increases while the other individual's investment decreases.

iii. Under Equal Awards, if the wealth of one of the group members increases, the investment of both the enriched individual and the other individual increases.

iv. Among the bankruptcy rules, the order in terms of total investment is Equal Losses > Proportionality > Equal Awards, and this order applies to all different endowment pairs.

CHAPTER 1

THEORETICAL STUDY [1]

1.1 LITERATURE REVIEW

There are studies in the axiomatic literature providing and analyzing bankruptcy principles such as Aumann and Maschler (1985), Dagan (1996), Herrero and Villar (2002). An extensive review of the axiomatic literature takes place in Thomson (2003) and Thomson (1994). The prominent rules studied are Proportionality (PRO), Equal Awards (EA), Equal Losses (EL), and the constrained versions of the last two of them (CEA, CEL). Aumann and Maschler (1985), Curiel, Maschler, and Tijs (1987), and Dagan and Volij (1997) employ cooperative games and find game theoretical solutions to them. On the other hand, Chun (1989), Dagan, Serrano, and Volij (1997) use a non-cooperative game-theoretical approach to study the Nash equilibria of the bankruptcy games induced by these prominent rules.

Another approach in this literature uses the strategical approach, in which the value of the asset is endogenous. In most cases, the asset's value and the possibly bankrupt value are formed after an investment process where agents make strategical investment decisions. When the rules such as Equal Losses, Equal Awards, or their constrained versions are chosen as a division rule, at the end of this project, one's outcome may be affected by others' investment decisions. This relationship makes the effect of bankruptcy principles on investment decisions compelling and valuable. Also, one's wealth might affect the amount of investment one can make. The

[1] A working paper based on this chapter, co-authored with Asst. Prof. Hayrullah Dindar and Assoc. Prof. Ayça Ebru Giritligil, is published in Murat Sertel Center Working Paper Series with Working Paper No: 2021-01.

wealth of others in a common project gains importance once again thanks to the nature of the rules mentioned above. The question of who are we investing together in the same company or project gains importance since after all wealth of other people might affect my outcome with the specified indirect route.

The two studies investigating the implications of bankruptcy principles on total investment levels in a strategical perspective are Karagözoğlu (2014) and Kıbrıs and Kıbrıs (2013). Karagözoğlu (2014) designs a non-cooperative game with two types of agents (high and low income) and analyses the consequences under proportional (PRO), constrained equal awards (CEA), and constrained equal losses (CEL). A fundamental assumption in the model is that the agents are risk-neutral, and this assumption induces corner solutions. That is, each agent chooses either zero investment or invests all her income. As a result, Karagözoğlu (2014) finds that PRO is the total investment maximizing rule.

Kıbrıs and Kıbrıs (2013), is the study more closely related to ours. They employ a non-cooperative game in which agents are assumed to be risk-averse. In the model, agents have Constant Absolute Risk Aversion (CARA) risk preferences. Thus, when everything else remains constant, a change in wealth does not lead to a change in equilibrium investment levels of agents. Parallel with the choice of CARA; they create a model where agents can borrow unlimited money from a bank with an interest rate normalized to 1. Agents borrow the amount of money corresponding to their equilibrium investment level, and after the end of the project, they pay the exact borrowed amount back. The model also assumes that each agent has the same credibility. In Kıbrıs and Kıbrıs (2013), Nash Equilibria analysis is made for proportional (PRO), equal awards (EA), and equal losses (EL). EL is singled out as a rule yielding the maximum total equilibrium investment among them. Additionally, they also perform a welfare analysis.

Our model differs from their work in this matter; thanks to the utility function, wealth becomes relevant, and agents react to the wealth changes. We consider agents endowed with Decreasing Absolute Risk Aversion (DARA) preferences. DARA preferences enable us to study the effect of changes in investors' wealth on all agents' investment levels. Thus, agents are endowed with some level of wealth, and they are expected to invest a non-negative amount that cannot exceed their wealth.

DARA type preferences are backed up by evidence in many studies in the experimental literature. Hamal and Anderson (1982) find experimental evidence for DARA among farmers in Nepal. Levy (1994) employs a dynamic portfolio choice experiment. The proportion of assets is modifiable in every round. After regressing the amount of risky investment in wealth, he finds that subjects exhibit DARA preferences. Brocas, Carrillo, Giga, and Zapatero (2019) assume individuals' utility functions belong to a very comprehensive broad family of functions in a more recent study. For different risk aversion parameters, this function becomes CARA, DARA, or IARA, and CRRA, DRRA, or IRRA. They set up an investment game with one safe and one risky asset and asked people to allocate their wealth dynamically between the assets. The main result of the paper is that most of the subjects show DARA and IRRA type preferences.

The rest of this chapter is organized as follows. In subsection 1.2, we explain the model. Subsection 1.3 conducts the Nash equilibrium analysis for each bankruptcy rule. We analyze the relation between the total equilibrium investment and the choice of bankruptcy rules in subsection 1.4. In subsection 1.5, we provide a computational illustration of the two-agent case. Finally, we conclude with closing remarks summarizing our results.

1.2 THE MODEL

Let $N = \{1, ..., n\}$ denote the set of agents interpreted as potential investors, where $n \geq 2$. Each agent $i \in N$ is endowed with the following Decreasing Absolute Risk-Aversion (DARA) utility function, $u_i(x) = \frac{1-\gamma_i}{\gamma_i}(\frac{x}{1-\gamma_i})^{\gamma_i}$,$\forall x \in R_+$ where $\gamma_i < 1$ for all $i \in N$. This function belongs to the class of Hyperbolic Absolute Risk-Aversion (HARA) type utilities $u(x) = \frac{1-\gamma}{\gamma}(\frac{x}{1-\gamma} + \eta)^{\gamma}$ first used in Merton (1971) for a dynamic portfolio allocation problem. For values of $\gamma < 1$, the function exhibits DARA, that is, as the wealth level of the agent increases, she will be willing to put more money at risk in absolute terms. HARA class of functions also exhibits increasing, constant, and decreasing relative risk aversion for $\eta > 0$, $\eta = 0$ and $\eta < 0$, respectively. We assume constant relative risk aversion, $\eta_i = 0$ for all $i \in N$, to simplify the functional form of our results in this study. Nonetheless, it should be noted that this assumption does not drive our results. Finally, without loss of generality, we assume that $\gamma_1 \geq \ldots \geq \gamma_n$. Thus, we assume that the level of risk aversion of agents increases with that index. Furthermore, it might be of interest to note that the natural logarithm (ln) utility specification, i.e. $u_i(x) = \ln(x)$, corresponds to the case of $\lim_{\gamma \to 0}$.

Each agent i is endowed with initial wealth $w_i \in R_+$ and simultaneously decides how much wealth to invest in a risky project. We denote the vector of wealth of all the agents by $w = (w_1, \ldots, w_n)$. Let $s_i \in [0, w_i]$ denote the investment of agent i. The vector of investment of all agents is denoted by $s = (s_1, \ldots, s_n)$, and following the investments, the total value of the project becomes S which is equal to the total value of the investments of the agents, $\sum_N s_i$. We let w_{-i} (resp. s_{-i}) denote the wealth (resp. investment) vector of all agents other than i, and with a slight abuse of notation we use N_{-i} (resp. S_{-i}) to denote $N \setminus \{i\}$ (resp. $\sum_{N \setminus \{i\}} s_i$).

With success probability $p \in (0, 1)$, the project brings a return $r \in (0, \bar{r}]$ where $\bar{r} \geq$

1, and the project's value becomes $(1+r)S$. If the project is successful, the resulting value, $(1+r)S$, is shared between the agents proportionally to their investments. Thus, an agent i with initial wealth w_i, would obtain $(w_i - s_i) + (1+r)S\left(\frac{s_i}{S}\right) = w_i + rs_i$ if the project succeeds. With the remaining probability $(1-p)$, the project goes bankrupt, and only the $\beta \in (0,1)$ fraction of the total value survives. That is, the remaining total value becomes βS. If the project goes under, the firm's value is allocated among the agents according to a prespecified bankruptcy rule.

This study examines the three most commonly studied bankruptcy rules and their convex combinations. Proportionality (PRO) implies that every investor receives money according to the ratio of her share in the firm. Under PRO, an agent's return is equal to $PRO_i(s) = \beta S\left(\frac{s_i}{S}\right) = \beta s_i$. The second rule is Equal Awards (EA), which implies that, following bankruptcy, every investor shares equally what is left from the firm. Under EA, an agent's return is $EA_i(s) = \frac{\beta}{n}S$. In a bankrupt firm's division phase, EA favors the smaller investor(s). The last rule we consider is Equal Losses (EL), which implies that the loss that occurred, $(1-\beta)S$, is shared equally among participants. Under EL, an agent's return is $EL_i(s) = s_i - \frac{(1-\beta)}{n}S$ from a bankrupt project. Since investors divide the loss occurred equally, the division ends in favor of bigger investor(s).[2] Given any $\alpha \in [0,1]$, the mixture applications of EA-PRO ($AP[\alpha]$) and EL-PRO ($LP[\alpha]$) are constructed by assigning weight α to PRO and the remaining weight $(1-\alpha)$ to EA (resp. EL). Thus, the return in case of bankruptcy for $AP[\alpha]$ is $AP[\alpha]_i(s) = \alpha PRO_i(s) + (1-\alpha)EA_i(s) = \alpha\beta s_i + (1-\alpha)\frac{\beta}{n}S$. Similarly, the return in case of bankruptcy for $LP[\alpha]$ is $LP[\alpha]_i(s) = \alpha PRO_i(s) + (1-\alpha)EL_i(s) = \alpha\beta s_i + (1-\alpha)\left[s_i - \frac{(1-\beta)}{n}S\right]$.[3] Thus, to summarize, the expected utilites of an agent i with wealth level w_i at an investment profile s when the underlying rule to be applied in case of bankruptcy is respectively PRO, $AP[\alpha]$,

[2] The well-known constrained version of EA and EL, respectively Constranied Equal Awards (CEA) and Constrained Equal Losses (CEL) are defined as follows. $CEA_i(s) = \min\{EA_i(s), s_i\}$, thus no agent may recive a return greater than her investment. Similarly, $CEL_i(s) = \max\{0, EL_i(s)\}$, thus no agent may recive a negative return.

[3] It is easy to see that for $\alpha = 1$, both $AP[\alpha]$ and $LP[\alpha]$ reduces to PRO. Similarly for $\alpha = 0$, both $AP[\alpha]$ reduces to EA and $LP[\alpha]$ reduces to EL.

and $LP[\alpha]$ are given by

$$U_i^{PRO}(s) = pu_i(w_i + rs_i) + (1-p)u_i\left[w_i - (1-\beta)s_i\right],$$

$$U_i^{AP[\alpha]}(s) = pu_i(w_i + rs_i) + (1-p)u_i\left[(w_i - s_i) + \alpha\beta s_i + (1-\alpha)\frac{\beta}{n}S\right], \text{ and}$$

$$U_i^{LP[\alpha]}(s) = pu_i(w_i + rs_i) + (1-p)u_i\left((w_i - s_i) + \alpha\beta s_i + (1-\alpha)\left[s_i - \frac{(1-\beta)}{n}S\right]\right). \quad (1)$$

Remark 1 We restrict the range of parameter values to ensure that for any $\alpha \in [0,1]$, at any equilibrium investment levels s^*, $AP[\alpha]_i(s^*) \leq s_i^*$ and $LP[\alpha]_i(s^*) \geq 0$. That is, the two rules conincide with their constrained versions. It should be noted that this also guarantees non-negative values of total money under $LP[\alpha]$ in case of bankruptcy. Thus, the expected utilities are well-defined.

1.3 ANALYSES OF BANKRUPTCY PRINCIPLES

In this subsection, we analyze the Nash equilibria and dominant strategy equilibria of the investment games corresponding to cases in which different prespecified bankruptcy rules are implemented.

1.3.1 Proportionality (PRO)

The following proposition shows that under Proportional rule (PRO) the investment game has a unique dominant strategy equilibrium:

Proposition 1 If $pr \leq (1-p)(1-\beta)$, the investment game under the rule PRO has a unique dominant strategy equilibrium $(0,\ldots,0)$. Otherwise, the game has a unique dominant strategy equilibrium s^* in which each agent i chooses a positive investment level s_i^* is given by

$$s_i^* = \frac{\left(1 - \left[\frac{pr}{(1-p)(1-\beta)}\right]^{\frac{1}{\gamma_i - 1}}\right) w_i}{\left[\frac{pr}{(1-p)(1-\beta)}\right]^{\frac{1}{\gamma_i - 1}} r + (1-\beta)}.$$

Proof In the appendix.

It is worth reemphasizing that, for $s_i^* > 0$ to be the unique dominant strategy equilibrium, $pr > (1-p)(1-\beta)$ should hold, which can be interpreted as follows. The left-hand side of the inequality is the expected return on one unit of investment, and the right-hand side is the expected loss of the agent on one unit of investment. It may also be noted that w_i is also positive by definition.

Another comment that directly follows from the above proposition is that for PRO, the optimal investment level s_i^* increases (decreases) as w_i increases (decreases). It is because individuals have DARA utility preferences, as their wealth increases, they become less risk-averse than before and are willing to put more money at risk. It is also worth noting that one could reinterpret this observation to consider an interpersonal comparison of two agents with the same γ values (which ensures that in case of having equal wealth both agents will be equally risk averse) and different levels of wealth. As a final remark, we note that an agent's investment decision is not affected by their opponents' wealth levels or risk attitudes under PRO. That is, given any agent $i \in N$ any change in the wealth levels or risk parameters of other agents does not lead to a change in the optimal investment level s_i^*.

1.3.2 EA-PRO Mixture Rule - $AP[\alpha]$

The following proposition determines the form of the unique Nash equilibrium under $AP[\alpha]$. We also consider the restriction on the model's parameter values so that at the Nash equilibrium, an agent's compensation in case of bankruptcy is no more than his investment, and no agent invests more than her wealth. Thus, we also consider as an additional constraint that the parameter values are such that $AP[\alpha]_i(s^*) \leq s_i^*$ and $w_i \geq s_i^* \geq 0$ for each $i \in N$. It should be noted that we have numerically shown that range of such parameter values is large enough, that is, even under this additional constraints, the model is reasonably rich.

Proposition 2 If $pr \leq (1-p)\frac{[n-\beta-(n-1)\alpha\beta]}{n}$, the investment game under the rule PRO has a unique Nash equilibrium $(0,\ldots,0)$. Otherwise, the game has a unique Nash equilibrium s^* in which each agent i chooses a positive investment level s_i^* given by

$$s_i^* = \frac{(1-A_i)w_i\left(\prod_N(A_i r+\delta)-C\sum_N\left[\prod_{N_{-i}}(A_j r+\delta)\right]\right)+C\sum_N\left[(1-A_i)w_i\prod_{N_{-i}}(A_j r+\delta)\right]}{[A_i r+\delta]\left(\prod_N(A_i r+\delta)-C\sum_N\left[\prod_{N_{-i}}(A_j r+\delta)\right]\right)},$$

where $A_i = \left[\frac{npr}{(1-p)[n-\beta-(n-1)\alpha\beta]}\right]^{\frac{1}{\gamma_i-1}}$, $C = (1-\alpha)\frac{\beta}{n}$, and $\delta = 1-\alpha\beta$, under the additional constraints that $AP[\alpha]_i(s^*) \leq s_i^*$ and $w_i \geq s_i^* \geq 0$.

Proof In the appendix.

Thus, to have $s_i^* > 0$ as the unique equilibrium investment level, $pr > (1-p)\frac{[n-\beta-(n-1)\alpha\beta]}{n}$ should hold. We could explain the left-hand side as the expected return on one unit of investment, and the right-hand side is the expected loss of the agent on one unit of investment.

Remark 2 It is worth noting that $pr > (1-p)\frac{[n-\beta-(n-1)\alpha\beta]}{n}$ and

$\prod_N [A_i r + (1-\alpha\beta)] > C \sum_N \left(\prod_{N_{-i}} [A_j r + (1-\alpha\beta)]\right)$ are sufficient conditions for $s_i^* > 0$ in the general case with any number of agents. For the special case of $n = 2$, i.e. only two agents, $s_i^* > 0$ follows from $pr > (1-p)\frac{[n-\beta-(n-1)\alpha\beta]}{n}$. Put differently, for the case of $n = 2$,
$\prod_N [A_i r + (1-\alpha\beta)] > C \sum_N \left(\prod_{N_{-i}} [A_j r + (1-\alpha\beta)]\right)$ condition is automatically satisfied as long as $pr > (1-p)\frac{[n-\beta-(n-1)\alpha\beta]}{n}$. Computationally, we have shown that the same result holds for $n = 3$. Nonetheless, due to complicated nature of the solution, it seems as a difficult problem to check whether one of the conditions implies the other for any number of agents.

In the following subsection, we restrict our attention to the analysis of equilibria under $AP[\alpha]$ rule, under the simplifying assumption of only two agents with a shared risk aversion parameter.

1.3.2.1 Two-agent Case

Two-agent case is a miniature version of the model with two investors, $i = 1, 2$, with equal risk aversion parameters ($\gamma_1 = \gamma_2 = \gamma$). The equilibrium investment level is obtained with the same procedure of n investor case. The reason this exercise seems relevant in our view is that there are many variables in n agent case affecting the optimal investment level, such as γ_i, w_i for $i \in N$. With this example and these assumptions, we will be able to analyze both total investment comparison for rules and see the effect of wealth more clearly.

Under the simplifying assumptions, we get:

$s_1^* = \frac{B_1[F-(1-\alpha)\beta]+(1-\alpha)\frac{\beta}{2}(B_1+B_2)}{F^2-(1-\alpha)\beta F}$, where

$A = \left[\frac{2pr}{(1-p)(2-\beta-\alpha\beta)}\right]^{\frac{1}{\gamma-1}}$, $B_i = (1-A)(w_i)$ for $i = 1,2$, $C = (1-\alpha)\frac{\beta}{2}$, and $F = Ar + (1-\alpha\beta)$.

Thus,

$$s_1^* = \frac{(1-A)w_1\left[Ar + (1-\beta)\right] + (1-\alpha)\frac{\beta}{2}(1-A)\left(w_1 + w_2\right)}{\left[Ar + (1-\alpha\beta)\right]\left[Ar + (1-\beta)\right]}.$$

All parts but $1 - A$ in the optimal investment level are positive. So the unique condition for equilibrium investment level to be strictly positive is $1 - A > 0$. And as in the n agent case, this condition reduces to $pr > (1-p)\frac{[n-\beta-(n-1)\alpha\beta]}{n}$.

The total investment $S = \frac{B_1F+B_2F}{F^2-(1-\alpha)\beta F} = \frac{B_1+B_2}{F-(1-\alpha)\beta} = \frac{(1-A)[w_1+w_2+2(1-\gamma)\eta]}{Ar+(1-\beta)}$.

As in the similar exercise for *PRO*, the equilibrium investment is increasing on w_1 under $AP[\alpha]$. Moreover, w_2 has an effect too. The reason for the presence of those variables in the formula is the DARA utility function assigned to each agent. For the broad range of $\gamma < 1$, investors with any risk aversion degree exhibit the same behavior concerning both their own wealth and the wealth of others. The wealth of the other investors have an effect on s_1 through the idea that for different wealth level of opponents', the amount of their investments vary. Further analysis of what happens when w_1 or w_2 increase (decrease) will take place in Section 4.

In order to make sure that no agent can earn more than her investment when she chooses to invest the optimal investment level, $s_i^* \geq \alpha\beta s_i^* + (1-\alpha)\frac{\beta}{2}S$ condition is necessary. The last necessary condition to be checked is $w_i \geq s_i^*$. For some small interval of values of parameters given, the optimal investment level might be greater than the endowment level of the agent. Since the whole process is an unconstrained optimization, this constraint has to be regarded exclusively.

1.3.3 EL-PRO Mixture Rule - $LP[\alpha]$

The following proposition determines the form of the unique Nash equilibrium under $LP[\alpha]$. We also consider the restriction on the model's parameter values so that at the Nash equilibrium, an agent's compensation in case of bankruptcy is nonnegative, and no agent invests more than her wealth. Thus, we also consider as an additional constraint that the parameter values are such that which $0 \leq LP[\alpha]_i(s^*)$ and $w_i \geq s_i^* \geq 0$ for each $i \in N$. It should be noted that we have numerically shown that range of such parameter values is large enough, that is, even under this additional constraints, the model is reasonably rich.

Proposition 3 If $pr \leq (1-p)\frac{(1-\beta)[1+(n-1)\alpha]}{n}$, the investment game under the rule PRO has a unique Nash equilibrium $(0,\ldots,0)$. Otherwise, the game has a unique Nash equilibrium s^* in which each agent i chooses a positive investment level s_i^* is given by

$$s_i^* = \frac{(1-A_i)w_i\Big(\prod_N(A_ir+\delta)+C\sum_N\Big[\prod_{N_{-i}}(A_jr+\delta)\Big]\Big)-C\sum_N\Big[(1-A_i)w_i\Big(\prod_{N_{-i}}(A_jr+\delta)\Big)\Big]}{(A_ir+\delta)\Big(\prod_N(A_ir+\delta)+C\sum_N\Big[\prod_{N_{-i}}(A_ir+\delta)\Big]\Big)},$$

where $A_i = \left[\frac{npr}{(1-p)(1-\beta)[1+(n-1)\alpha)]}\right]^{\frac{1}{\gamma_i-1}}$, $C = \frac{(1-\alpha)(1-\beta)}{n}$, $\delta = (1-\beta)\alpha$, under the additional constraints that $0 \leq LP[\alpha]_i(s^*)$ and $w_i \geq s_i^* \geq 0$.

Proof In the appendix.

So to have $s_i^* > 0$ as equilibrium investment level, $pr > (1-p)\frac{(1-\beta)[1+(n-1)\alpha]}{n}$ should hold. We could explain the left-hand side as the expected return on one unit of investment, and the right-hand side is the expected loss of the agent on one unit of investment. In order to have every investor not suffering losses more than their investment, s_i^* should be greater or equal to the loss anyone faces in the case of bankruptcy. That is, $s_i^* \geq \alpha(1-\beta)s_i^* - (1-\alpha)\frac{(1-\beta)}{n}S$. The last condition we should keep in mind is that the optimal investment level should not exceed wealth, that is, $w_i \geq s_i^*$.

1.3.3.1 Two-agent Case

Now we consider a miniature version of the model with two agents, $i = 1, 2$, experiencing equal risk aversion parameters, i.e., $\gamma_1 = \gamma_2 = \gamma$. The equilibrium investment follows from our previous result on n investor case, proposition 3. The reason we are analyzing this simplified version is the intractability of the general model. Under these assumptions, we will be able to analyze both total investment comparisons for rules and see the effect of wealth.

This time, using a similar notation as above:

$A = \left[\frac{2pr}{(1-p)(1-\beta)(1+\alpha)}\right]^{\frac{1}{\gamma-1}}$, $B_i = (1-A)(w_i)$ for $i = 1, 2$, $C = \frac{(1-\alpha)(1-\beta)}{2}$, $F = Ar + \alpha(1-\beta)$,

$s_1^* = \frac{B_1[F+(1-\alpha)(1-\beta)] - \frac{(1-\alpha)(1-\beta)}{2}(B_1+B_2)}{F^2+(1-\alpha)(1-\beta)F}$, which simplifies to

$$s_1^* = \frac{(1-A)(w_1)\left[Ar + (1-\beta)\right] - \frac{(1-\alpha)(1-\beta)}{2}(1-A)(w_1+w_2)}{\left[Ar + \alpha(1-\beta)\right]\left[Ar + (1-\beta)\right]}.$$

With a similar exercise, we can only talk about a positive investment where $1 - A$ is already positive. After that is satisfied, the condition for s_1^* to be a positive equilibrium is $B_1\left[F + (1-\alpha)(1-\beta)\right] > \frac{(1-\alpha)(1-\beta)}{2}(B_1 + B_2)$.

So to have $s_i^* > 0$ for $i = 1, 2$ as equilibrium investment level, $pr > (1-p)\frac{(1-\beta)(1+\alpha)}{2}$ should hold. As before, one can interpret the left-hand side as the return on unit investment when the firm succeeds, the right-hand side as the loss agents face in the case of bankruptcy.

The total investment $S = \frac{B_1F+B_2F}{F^2-(1-\alpha)\beta F} = \frac{B_1+B_2}{F-(1-\alpha)\beta} = \frac{(1-A)(w_1+w_2)}{Ar+(1-\beta)}$.

For agent i, different wealth levels or changes in wealth induce different levels of equilibrium investment, s_i^*. The effect of each agent's own wealth is increasing on the investment. The wealth of the other investors has an effect on i's investment too, but this time it has a negative effect. The logic behind this is $(1-\alpha)$ share of the loss incurred will be suffered equally by investors. According to the model, if an opponent has greater wealth than before, she would invest more, and now the smaller investors will be facing this danger of sharing equally a greater total loss. So, they decrease their investment in order to prevent losing more and more in case of bankruptcy.

1.4 COMPARISON OF PRINCIPLES - TOTAL EQUILIBRIUM INVESTMENT

We examine mixed rules, $AP[\alpha]$ and $LP[\alpha]$, to determine which principle induces the highest total investment and which one induces the lowest. We restrict our attention to the 2 agent case for the sake of simplicity on expressions where both agents have the same absolute risk aversion parameter, i.e., $\gamma_1 = \gamma_2 = \gamma$. It should be noted that this approach allows us to compare not only pure PRO, EA, and EL among themselves but also talk about the effect of changing the weight, α. Let us start with the comparison of EA and PRO through $AP[\alpha]$.

Proposition 4 (EA vs. PRO - $AP[\alpha]$) PRO leads to weakly higher equilibrium total investment than EA , i.e. $PRO \geq EA$. Furthermore, at any parameter values that leads to strictly positive investments at equilibrium, the inequality is strict, i.e. $PRO > EA$.

Proof There are three cases to consider:

Case 1) If $pr > \frac{(1-p)(2-\beta-\alpha\beta)}{2}$, $(1-A>0)$, $\forall\alpha \in [0,1]$, for each $AP[\alpha]$ principle, all investors have positive equilibrium investment levels. In this case:

$$S = \frac{(1-A)(w_1+w_2)}{Ar+(1-\beta)} = \frac{\left(1-\left[\frac{2pr}{(1-p)(n-\beta-\alpha\beta)}\right]^{\frac{1}{\gamma-1}}\right)(w_1+w_2)}{\left[\frac{2pr}{(1-p)(n-\beta-\alpha\beta)}\right]^{\frac{1}{\gamma-1}}r+(1-\beta)},$$

where S is the total equilibrium investment. If we take partial derivative of S with respect to α; $\frac{\partial S}{\partial \alpha} > 0$ is the result. Therefore, as α increases, share of PRO increases and equilibrium total investment under $AP[\alpha]$ also increases. When the constraints for positive investment are satisfied, PRO yields greater total investment than EA.

Case 2) If $pr = \frac{(1-p)(2-\beta-\alpha\beta)}{2}$ for some $\alpha^* \in [0,1]$, since the term is increasing in α, the first case applies $\forall\alpha \in (\alpha^*,1]$. On the other hand, $\forall\alpha \in [0,\alpha^*)$ one has $pr < \frac{(1-p)(2-\beta-\alpha\beta)}{2}$ as in case 3, and all of these levels induce zero investment.

Case 3) If $pr < \frac{(1-p)(2-\beta-\alpha\beta)}{2}$ $\forall\alpha \in [0,1]$, all $AP[\alpha]$ rules induce zero investment.

We can conclude with the result $PRO > EA$ at any parameter values which leads to positive investments, and $PRO \geq EA$ in general.□

Similarly, the comparison of EL and PRO is carried by taking the derivative of total investment under $LP[\alpha]$ w.r.t. α, and we get the following proposition.

Proposition 5 (EL vs. PRO - $LP[\alpha]$) EL leads to weakly higher equilibrium total investment than PRO , i.e. $EL \geq PRO$. Furthermore, at any parameter values that leads to strictly positive investments at equilibrium, the inequality is strict, i.e. $EL > PRO$.

Proof As in the proof of preceeding proposition, there are three cases to consider:

Case 1) If $pr > \frac{(1-p)(1-\beta)(1+\alpha)}{2}$ $\forall \alpha \in [0,1]$, for each $LP[\alpha]$ principle, all investors have positive equilibrium investment levels. In this case:

$$S = \frac{(1-A)(w_1+w_2)}{Ar+(1-\beta)} = \frac{\left(1-\left[\frac{npr}{(1-p)(1-\beta)(1+(n-1)\alpha)}\right]^{\frac{1}{\gamma-1}}\right)(w_1+w_2)}{\left[\frac{npr}{(1-p)(1-\beta)(1+\alpha)}\right]^{\frac{1}{\gamma-1}}r+(1-\beta)},$$

where S is the total equilibrium investment. If we take partial derivative of S with respect to α; $\frac{\partial S}{\partial \alpha} < 0$ is the result. Therefore, as α increases, share of PRO increases and the equilibrium total investment under $LP[\alpha]$ decreases. When the constraints for positive investment are satisfied, EL yields greater total investment than PRO.

Case 2) If $pr = \frac{(1-p)(1-\beta)(1+\alpha)}{2}$ for some $\alpha^* \in [0,1]$, since the term is increasing in α, the first case applies $\forall \alpha \in (\alpha^*, 1]$. On the other hand, $\forall \alpha \in [0, \alpha^*)$ the term $pr < \frac{(1-p)(1-\beta)(1+\alpha)}{2}$ and all of these levels induce zero investment.

Case 3) If $pr < \frac{(1-p)(1-\beta)(1+\alpha)}{2}$ $\forall \alpha \in [0,1]$, all $AP[\alpha]$ rules induce zero investment.

We can conclude with the result $EL > PRO$ at any parameter values which leads to positive investments, and $EL \geq PRO$ in general.□

Before proceeding to next section, where we provide a computational illustration of the two-agent case, let us summarize our results concerning comparison of the rules in terms of total equilibrium investment levels. As a straightforward corollary of the preceding two propositions, we get the following corollary.

Corollary 1 The ranking of principles in terms of equilibrium total investment is $EL \geq PRO \geq EA$. Furthermore, at any parameter values that leads to strictly positive investments at equilibrium, the inequalities are strict, i.e. $EL > PRO > EA$.

Proof The results follow directly from conjunction of the two preceding propositions.

1.5 PRO VS. EA VS. EL: ILLUSTRATIONS OF TOTAL INVESTMENT COMPARISONS VIA COMPUTATIONS

Let $n = 2$, $\beta = 0.6$, $p = 0.5$, $r = 2$, $\gamma_1 = \gamma_2 = -1$, and $\alpha = 0$ means the principles will be pure EA and EL. Initially, both agents have DARA utility function with equal γ values and equal wealth; hence, they are equally risk-averse. Therefore, they are expected to yield the same investment levels at equilibrium. We will investigate the changes occurring in the equilibrium investment level of agent 1 and 2, s_1^*, s_2^*, under three principles. The story here is that wealth changes while everything else remains constant. However, wealth change is not necessary to be actualized. Comparing two different wealth levels would also be enough, and our finding still applies.

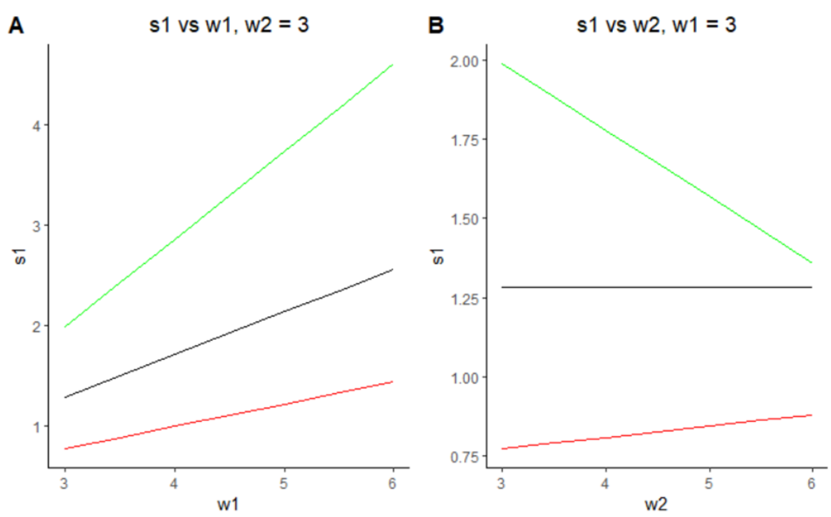
Findings from Section 2 are as follows:

1. Wealth is a determinant of the amount of investment, and if w_1 rises, that leads to a rise in s_1^*, vice versa. Underlying reasoning was explained before, by the assumption made with the agent's utility function, individual risk aversion changes with wealth or takes different values for different wealth levels.

2. When n agents invest in a project together under EA or EL, the wealth of other investors affects s_1^*. A change in an opponent's wealth triggers an increase or decrease in one's investment, thanks to DARA. Directions of this reaction will be analyzed with computations and figures.

3. In the equilibrium, where $n = 2$, the rankings of principles in total investment are $EL > PRO > EA$. This proven finding will be further illustrated with computations.

Figure 1.1: Green Line: EL, Black Line: PRO, Red Line: EA.



In Figure 1.1, both agents have equal starting wealths, $w_1 = w_2 = 3$. Graph A shows what happens to the s_1^* when w_1 continuously increases from 3 to 6, while w_2 is equal to 3. The computation with given parameters at the beginning of the section reflects an intuitive finding of our results. The level of wealth influences investment levels when all other parameters are held constant. Consistent with the idea behind DARA, wealth increase has a positive effect on investment, and s_i increases under all principles.

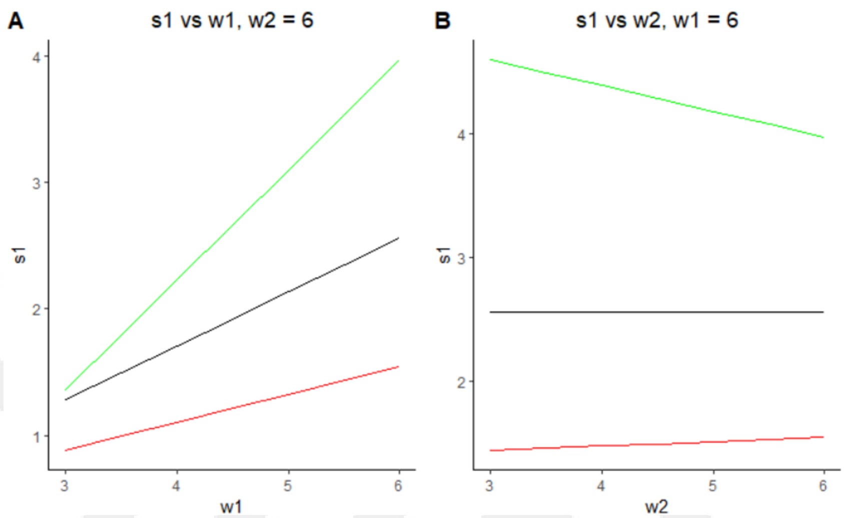
Graph B shows reactions of s_1^* to the changes in w_2. We consider the case where w_2 continuously increases from 3 to 6 this time, and w_1 is equal to 3. This graph aims to clarify the influence of the increase in w_2 on s_1^*. By its nature, under PRO, s_1^* is not affected by changes in w_2. As a result, the black line is flat, and s_1^* is constant through the levels of w_2.

EA is the rule in favor of smaller shareholders. Note that s_i^{EA} starts from the same value in Graph A and B when $w_i = w_j = 3$. We saw that in Graph A, investment rises as own wealth does so. This means 1 will invest more when w_1 increases. So 1 starts to be a bigger shareholder, and we know that EA favors smaller shareholders in the state of bankruptcy. Even though she gets a disadvantage by being a bigger shareholder, the effect coming from her own wealth overrides the disadvantage of holding more shares. In Graph B, on the other hand, w_1 does not change, and there is no own wealth effect on s_1^*. However, as s_2^* increases thanks to w_2, 2 becomes the bigger shareholder. Now the situation of being a bigger shareholder is less likely for 1, so s_1^* slightly increases. This is important to see, even though w_1 does not change, s_1 changes related to the change in w_2. We can see the red line in B is flatter than the one in A.

EL is the rule in favor of those who invested more in the project. In that sense, in Graph A, EL has the greatest slope. When w_1 becomes greater than $w_2 = 3$, 1 starts to hold more shares than 2. So she gets the advantage of sharing the loss equally. That is the reason behind the green line is steeper than PRO. If the project goes under, 1 will not bear the loss of the whole amount she invested but share it equally with 2.

In Graph B, since w_2 rises, the explanations above apply to her investment attitude. As a result, 1 starts being holding less share since w_2 and s_2^* went up. Finally, her reaction to an increase in the opponent's investment will be decreasing her investment gradually. Since w_i is constant, there is no wealth effect thanks to an increase in w_1 like Graph A. We see the effect coming from the opponent's wealth, w_2. The green line in both graphs starts at the same level of investment.

Figure 1.2: Green Line: EL, Black Line: PRO, Red Line: EA.



In Figure 1.2, initial wealth of the investors are not equal. In graph A, 2 has greater wealth than 1 and in B it is the opposite. Graph A shows what happens to the s_1^* when w_1 goes from 3 to 6, while w_2 stays constant at 6. Similar to Figure 1.1, Graph A in Figure 1.2 also reveals that the change in w_1 has a positive effect on s_1^*. In Graph B, 1 has more wealth this time, and w_2 reaches to her wealth. The whole process of PRO is the same as in Figure 1.1.

Under EA, in Graph A, w_1 starts at 3, and this means 1 is more likely to be in an advantageous situation by holding less share than 2. Nevertheless, the rise of w_1 results in an increase in investment. In B, 1 is a relatively rich one in this pair, and while the wealth difference decreases, 1 raises her investment. While the wealth difference is decreasing, also the difference of s_1^* and s_2^* decreases. For every value of w_2 while it increases, 1 faces less punishment from being a leading shareholder. That creates a positive reflection of s_1^* and yields a slight increase.

Under EL, in Graph A, since 1 is the poorer agent, we can say 2 invests more when

$w_1 = 3$. So, 1 will suffer from the equal division of losses. The green line is steeper than the other two lines because both own wealth increase effect and lowering the wealth difference as a secondary effect positively influences s_1^*. In B, 1 has the advantage of being relatively rich and is investing more than she would in a case of equal wealth. As w_2 rises and the wealth difference disappears, 1 gradually loses the advantage of EL and decreases s_1^*.

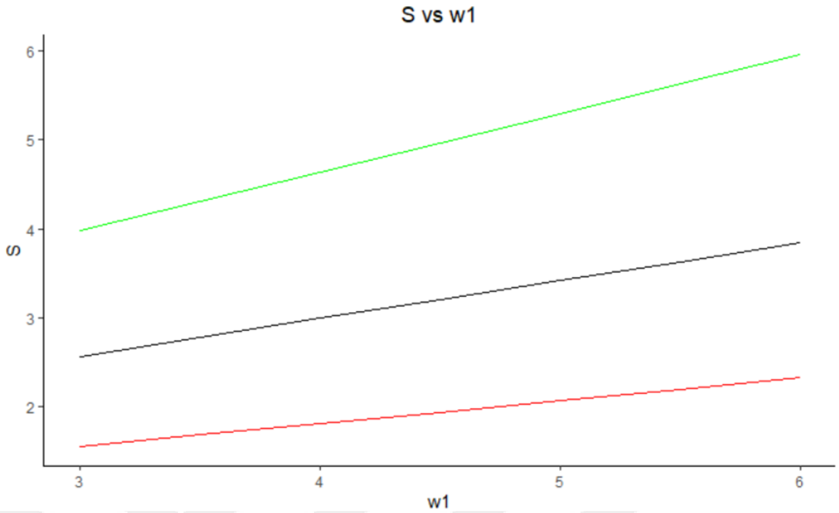
Graph A in both Figures 1.1 and 1.2 shows the effect of personal wealth increase. Aforementioned, wealth change is not necessary to be actualized. Comparing two agents with different wealth would also be enough, and our findings continue to apply.

Let us say there are two people with different decreasing absolute risk aversion (trying to make an inference for real life). And they have some value of wealth in the beginning. If we raise their wealth, we will observe the impact of their own wealth increase under all three principles. Since under PRO, w_1 is the only wealth component of s_1^*, we can see the effect of agent's own wealth clearly. Under the other two principles, the result would consist of the combination of own wealth's and wealth of others' effects.

Graph B in both Figures 1.1 and 1.2 shows the effect of an increase in the opponent's wealth. In the analysis part, thanks to the equal risk aversion assumption with γs, we can be sure that if an agent has a greater wealth than the other, she would invest more than the other. Nevertheless, when people who have different risk aversion for the same amount of wealth get involved in the investment, even if one has greater wealth, she might not make more investment than others. However, this does not lead the finding to lose its experimental interest. It can still be contested in an experimental study.

Total investment under the three principles is shown in Figure 1.3. It clearly shows

Figure 1.3: **Green Line: EL, Black Line: PRO, Red Line: EA.**



the ranking between principles in terms of S is $EL > PRO > EA$. With the parameters of the model specified in the beginning of this section, EL has the steepest slope. Wealth difference gives the greatest rise to total investment under EL. Another fact is the one's own wealth increase overrides the effect of opponent's wealth increase when they encounter.

CONCLUSION

We study a bankruptcy problem with $n \geq 2$ agents endowed with DARA utility functions, where we focus on equilibrium properties of three bankruptcy rules, namely, PRO, EA, and EL. Our first set of results, proposition 1, 2, and 3 establish the equilibrium behavior of agents for the bankruptcy corresponding to PRO, $AP[\alpha]$, and $LP[\alpha]$. These three propositions are stated and proved for the general case of $n \geq 2$ and possibly differing degrees of absolute risk aversions.

Due to the complex nature of the equilibria in the general version, we switch to a two-agent case (with a shared risk aversion parameter for both agents) in further analysis of the equilibria.

Our first set of results from further analysis concerns the effect of own wealth and other's wealth on the equilibrium investment. It turns out that independent of the bankruptcy rule to be applied in case the project fails, an increase in own wealth leads to an increase in equilibrium investment. On the other hand, an increase in other agent's wealth leads to no change (resp. increase, decrease) if PRO (resp. EA, EL) is the bankruptcy rule applied.

We then turn to a comparison of equilibrium total investment levels for different bankruptcy rules. We show that in terms of S, $EL > PRO > EA$. Our last section provides several illustrations from computations with different parameter sets that summarize and hopefully further clarify our results.

CHAPTER 2

EXPERIMENTAL STUDY

2.1 LITERATURE REVIEW

With the popularity increase in experimental studies, bankruptcy experiments started after the 2000s. Gächter and Riedl (2005) had a free-form bargaining setup with two sides having unequal claims. A crucial part is the deservingness created for assigned claims. Subjects were ranked according to their success in a general knowledge competition. The ”winner” of the contest was told that she had a better result than her opponent, and the ”loser” was told the opposite. The winner's claim was twice her opponent's. According to the probabilistic state, the firm's value can either meet the claims of the two subjects in the group or the value goes bankrupt. The free-form bargaining and arbitration question stages took place afterward.

Results obtained in the free form bargaining phase and the decisions made as an arbitrator were put in comparison. Both types of subjects (winners and losers of the test) predicted that assets should be divided according to PRO. In line with this, the common result of the bargaining stage fits with PRO. In Gächter and Riedl (2006), claim differences in the model were enriched. The question was how the inequality of claims affects both bargaining and normative results. While PRO is the result of the arbitrator question, the result of the bargaining stage is Constrained Equal Awards (CEA).

Herrero, Moreno-Ternero, and Ponti (2010) makes subjects play three games with different scenarios in groups of three. When subjects are about to share a bankrupt value, they are asked which rule they prefer. Options include Proportionality, Constrained Equal Losses, and Constrained Equal Rewards. Each of the three sharing rules that can be chosen in each scenario is in the interest of only one player within the group and provides an extra advantage. If the chosen rule was voted by the Majority, it was analyzed. Results support that PRO is the prominent division rule.

Cappelen, Luttens, Sorensen, and Tungodden (2018) creates a production process using a real-effort task and enables subjects to have a claim in the companies according to their effort. If the company goes under, a third party, the arbitrator decides the division between the stakeholders. It was stated that 85% of the referees chose the PRO to be executed.

Loss-sharing problems are suitable to be considered in the same class of bankruptcy problems. Gaertner, Bradley, Xu, and Schwettmann (2019) assigns 5-10-15-20 points as endowments to subjects in groups of four. The group faces a 10 points loss, and negotiations start on who should pay how much to cover the total loss. A randomly selected person proposes a distribution about how much each member should pay; if the proposal is accepted by voting, it happens. If it is rejected, the turn of the proposal is randomly passed to another member. According to the distributions realized in the experiment, the result is against the proportionality principle.

Under different bankruptcy rules, how the behaviors of the investors change is a question that needs to be answered. In order to contribute to that, Büyükboyacı (2017) constructs an investment game where subjects decide the amount to invest in a group project. Two investors form one group. After the contribution, the value of the project increases with success probability (*p*), and shrinks with bankruptcy probability (*1-p*). If the project succeeds, an interest revenue proportionate to their investment is awarded to the investors. If the project goes under, they use the previously declared bankruptcy rule, either EL or PRO, to share the bankrupt value. Risk neutrality is assumed for all investors in the model. First, subjects decide on "how much they would contribute if PRO is applied", then they decide on "how much they would contribute if EL is applied". Afterward, investors state their preference for the bankruptcy rule to be employed. Moreover, they are asked how much the other group member would have contributed. This last part elicits an investor's belief on the other one's behavior.

The amount of contributions under different rules, rule preferences of the subjects, and demographic data are examined. Büyükboyacı (2017) concludes that subjects believe the other group member would invest under both rules as much as their own investment. Also, subjects who are indifferent between bankruptcy rules and investment levels under both rules are similar.

One other experimental study examining the effect of the determined bankruptcy principle on investment levels is Büyükboyacı et al. (2019). Employing the theoretical model of Kıbrıs and Kıbrıs (2013), they constructed an experiment where investors make an investment in a risky project in groups of two. According to the study's model, people have CARA preferences. As a result, an investor with a specific Constant Absolute Risk Aversion level invests the same amount regardless of her wealth or a change in her wealth. In fact, Kıbrıs and Kıbrıs (2013) enables agents to take unlimited loans without interest.

The experiment starts with a risk elicitation stage using Holt and Laury (2002) method, which enables measuring risk aversion levels in CARA class. The second stage consists of an investment game where the total value of investments can rise or shrink at the end of a probabilistic state. Accordingly, if the investment is successful, the total value of investments will double, and if it goes bankrupt, it will be multiplied by 0.4. In case of success, the total value is divided among team members according to PRO. Otherwise, the shrunk value of the project is divided according to the pre-determined bankruptcy rule.

Subjects are endowed with 400 tokens each round and decide how much of it they will invest in the team project. At the beginning of each round, subjects are informed that both she and the other member of the group were endowed with 400 tokens. In all of the sessions held, the token endowed to each group member in each round of the investment game is 400. Hence, the study examines the effect of chosen bankruptcy principle on investment decisions only when both investors have equal endowments. At the end of each round, subjects are told how much the other person in the group invested, whether there was bankruptcy or success and what her earnings are from the project.

Subjects are divided into a certain number of matching groups and randomly matched each round with one person in the matching group they belong to. There are 36 rounds of investment games in a session as nine rounds under PRO, followed by nine rounds of Equal Losses, nine rounds of Proportionality, and nine rounds of Equal Losses. Considering that the order of the rule change may create an anchoring and ranking effect, the sequences were changed in different sessions. Sessions were held for PRO and Equal Awards with a similar pattern. As it is clearly revealed in the design, only the investments of individuals under an equal and fixed endowment are examined. While the amount they invested in between 0 and 400 creates a project income according to success or bankruptcy, the amount they set aside is added to their earnings by staying constant.

The hypotheses are parallel to Kıbrıs and Kıbrıs (2013) such that investors' total investment increases when moving from PRO to EL and decreases when moving from PRO to EA. In addition, if the probability of success "p" increases, the total investment increases. Finally, there are also hypotheses that if the individual's degree of risk aversion increases, the total investment decreases.

According to their results, the average investment levels under bankruptcy rules align with the hypotheses. Also, total investment increases with p according to the sessions applied with different values of p. As a result of the regression analysis, it was concluded that the individual's own risk aversion level is one of the critical determinants of own investment decisions. However, the effect of wealth was not examined both in the experiment and the article forming the theoretical background of the experiment. The question of ”how the changes in subjects' own or the other investor's wealth affect the investment levels” has not been investigated.

In this experiment, the model relies on investors' risk preference assumption. Therefore, DARA should be a reasonable risk aversion class to be included in the explanation process of investment decisions. There are behavioral evidences from several studies in various fields of the literature. Benzion and Yagil (2003) collects data for a wide variety of portfolio selections at various levels of wealth and finds support for DARA. Paravisini, Rappoport, and Ravina (2016) concludes that DARA and DRRA are plausible based on investors' portfolio choices. Finally, Eisenhauer and Ventura (2003) uses the data of a survey conducted by the Bank of Italy to estimate the ARA and RRA of Italian households. According to the answers given to the hypothetical questions regarding a risky asset, evidence is found for DARA and IRRA.

Absolute risk aversion is measured by Guiso and Paiella (2008) by utilizing the Bank of Italy Survey of Household Income and Wealth. The participants' wealth and willingness to pay for a risky asset are associated, and results suggest that willingness to pay increases with wealth. Schmidt, Neyse, and Aleknonyte (2019) analyze the effect of income inequality and the knowledge of the inequality on investment decisions and risk aversion. As a result of the real effort task, participants are assigned with high and low income in an environment where deservingness is present. Only half of the subjects were aware of the inequality, and in the second part, they were asked to invest in a risky asset. If they were informed about the income inequality, subjects with higher income have taken more risks compared to the subjects with low income.

Risk attitude holds an essential place in explaining the investment behavior of agents in bankruptcy problems, among other contexts. Theoretical studies such as Karagözoğlu (2014), Kıbrıs and Kıbrıs (2013) and Chapter 1 of this thesis assume either risk neutrality or a specific class of risk aversion. The most frequently used Holt and Laury (2002) method enables experimenters to measure the level of Constant Absolute Risk Aversion ($CARA$). It consists of ten questions, and in each one, participants are asked to choose between options A and B. This is also called the Multiple Price Listing method. Option A is safer compared to B in all of the ten questions. The subjects' risk preferences are determined by the number of questions they switch from A to B.

Eckel and Grossman (2002) asks subjects to choose a gamble between six different gambles. From one to six, both the expected return and the standard deviation of the gambles increase. Their setup enables measuring the Constant Relative Risk Aversion ($CRRA$) class. However, these elicitation techniques might not be the best way to analyze risk preference while agents are assumed to have Decreasing Absolute Risk Aversion (DARA) utilities.

Levy (1994) is a study testing hypotheses of Arrow (1971) on investors being characterized by DARA and IRRA. Each subject was endowed with the same amount of paper money and was given the same list of stocks. The 20 stocks have different mean returns, standard deviations, and asset values at time 0. The value of the stocks changes each period, either rising or declining randomly. The random variable was taken from a normal distribution with the mean and variance of the stock. There was also a risk-free asset with a %2 return. Risky investments of the agents were regressed on the investor's net wealth just before the investment decision was made. To support the DARA hypotheses, the coefficient of net wealth should be significantly positive. As a result of regression analysis, 49 out of 62 subjects performed the features of DARA.

The risk elicitation methodology used in this experiment was tested by Brocas et al. (2019). The setup was a dynamic portfolio allocation model from Merton (1971). A hyperbolic absolute risk aversion (HARA) utility function was employed in order to solve the portfolio optimization problem of a risk-averse agent. This class contains most of the frequently used utility functions in the literature. The aim is to have many classes included while characterizing the risk preferences of subjects. The question asked to subjects was how much they wanted to invest in a risky asset against a safe one.

There were 15 paths in a session, and in the first period of each path, subjects were endowed with 3 USD. After the investments were made, subjects were informed of the result of their investment and the total remaining value of their portfolio. In the following periods, they decided on how much to invest from their recent portfolio value. This went on until one path ended and a new one started. When period 10 ends, the new path starts with a 3 USD endowment. In this order, 15 paths were played, and the results were shown. The study concludes that 84% of the subjects show DARA risk attitudes.

2.2 EXPERIMENTAL DESIGN

The experiment consists of 3 stages and a questionnaire. In the first stage, there is an investment game where subjects decide how much to invest of their endowment in a risky project. The second stage aims to elicit the beliefs of subjects on the investment decisions of other players. In the third stage, there is a dynamic portfolio allocation game to elicit the risk preferences of the players.

2.2.1 Stage 1: Investment Decisions

2.2.1.1 Model

The theoretical framework of the bankruptcy problem examined is similar to the model in Chapter 1. Each agent $i \in N$ in set of agents $N = \{1, ..., n\}$ are assumed to have the following Hyperbolic Absolute Risk Aversion (HARA) utility function, $u_i(x) = \frac{1-\gamma_i}{\gamma_i}(\frac{x}{1-\gamma_i} + \eta_i)^{\gamma_i}$,$\forall x \in R_+$ and $\gamma_i \neq 1$. For all $i \in N$, it is assumed that $\gamma_i < 1$ is the case where the utility function is Decreasing ARA for all agents. For $\gamma_i > 1$, the function exhibits Increasing ARA and when $\gamma_i \to \infty$ or $\gamma_i \to -\infty$ it exhibits Constant ARA. Also, due to the value of η_i, the function exhibits increasing, constant, and decreasing relative risk aversion for $\eta > 0$, $\eta = 0$ and $\eta < 0$, respectively. For the sake of simplicity, $\eta_i = 0$ is assumed $\forall i \in N$, implying Constant RRA. Without loss of generality, it is assumed that $\gamma_1 \geq \ldots \geq \gamma_n$.

Particularly for this stage of the experiment, $N = 2$ as Stage 1 takes place in groups of two. Participants whose individual wealth, w_i, is defined exogeneously, will simultaneously decide how much of w_i to invest in a risky project. Each investment level, s_i for $i = 1, 2$, sum up to total value of the project, S. In the end of each round, the project might be successful with success probability, $p \in (0, 1)$. In this case, project provides an interest, $r \geq 1$, and the total value of the project increases to $(1+r)S$. This value is divided in proportion to investment levels of group members. If the project goes under with the probability $(1-p)$, only the surviving fraction, $\beta \in (0,1)$, of the total investment survives. The remaining value of the project, βS, is divided between investors according to pre-specified bankruptcy rule. Values of $\gamma < 1$ is assumed but $\gamma_1 = \gamma_2$ is not required. The previous assumption on the values of η is also loosened as $\eta_i = 0$ is not assumed for $i \in 1, 2$.

The three bankruptcy rules used in the experiment are pure Proportionality (*PRO*), Equal Awards (*EA*) and Equal Losses (*EL*). Mixed rules such as $AP[\alpha]$, $LP[\alpha]$ are not considered. Therefore, as the weight of *PRO* in mixed rules, $\alpha = 0 \ \forall \alpha$ in Chapter 1. Under *PRO*, every investor earns an amount according to her share in total investment. An agent's return is equal to $PRO_i(s) = \beta S \left(\frac{s_i}{S}\right) = \beta s_i$. *EA* defines an agent's return as $EA_i(s) = \frac{\beta}{2}S$, dividing the remaining value of the project equally between investors. The third rule, *EL*, implies that the total loss faced, ($(1-\beta)S$), is shared by investors equally. This makes an agent's return equal to $EL_i(s) = s_i - \frac{(1-\beta)}{2}S$. *PRO* is binding also whenever project ends successfuly.

As a result of the Nash equilibria analysis placed in Chapter 1, according to Proposition 1, PRO generates a unique dominant strategy equilibrium. As a result, agents make a positive investment in equilibrium if the expected return in case of success exceeds the expected loss faced in case of bankruptcy.

Following Proposition 2 of Chapter 1, when $n = 2$ under EA, there is a unique Nash Equilibrium without dominant strategy equilibria. For $s^* > 0$, the conditions are $pr > (1-p)\frac{[2-\beta]}{2}$ and $(w_i + (1-\gamma i)\eta_i) > 0$. The first one can be explained as the expected return on a unit of investment being greater than the expected loss of on one unit of investment in case of bankruptcy. The second one might not hold only with the extremely negative values of η, which are not expected.

Following Proposition 3 of Chapter 1, when $n = 2$ under EL, there is a unique Nash Equilibrium without dominant strategy equilibria. So to have $s^* > 0$, $pr > (1-p)\frac{(1-\beta)}{2}$ and $(w_i + (1-\gamma i)\eta_i) > 0$ should hold among other conditions[4]. The first one can be explained as the expected return on one unit of investment being greater than the expected loss of on one unit of investment in case of bankruptcy. Again, the second one might not hold only with the extremely negative values of η, which are not anticipated.

The chosen parameter values should induce an equilibrium with positive investment while satisfying the following constraints. For all three principles, $w_i \geq s_i^*$ should hold. For EA, the return in case of bankruptcy should not exceed each agent's investment amount. For EL, the loss accrued in case of bankruptcy should not exceed the amount invested. In other words, one should not earn a value below zero from the project. Following parameters are chosen regarding those criteria for a reasonably wide range of risk aversion parameter values.

Table 2.1: Parameter values.

p	0.5	Probability of success
β	0.5	Surviving fraction
r	2	Interest in case of success
w	300,600	Endowments

[4]Please see the proof of Proposition 3.

2.2.1.2 Hypotheses

Following the results of the theoretical framework, the hypotheses are as follows:

Hypothesis 1: *As one's endowment changes, her investment changes in the same direction under PRO.*

Hypothesis 2: *As the endowment of other investors changes, one's investment remains the same under PRO.*

The first hypothesis implies that whenever an investor's own wealth increases (decreases), she reacts with an increase (decrease) in her investment. The second hypothesis means that investors are expected to invest the exact same amount when they have 300 points, regardless of whether the opponent's wealth is 300 or 600. Similarly, when one has 600 points, she is expected to invest the same amount when the opponent has 300 or 600 points.

Hypothesis 3: *If an investor is wealthier than the other investor under EA, she reacts with an increase in her investment. The amount she invests as the richer one is smaller than the amount she invests with the same endowment while her partner is equally wealthy.*

Hypothesis 4: *If an investor is poorer than the other investor under EA, she reacts with an increase in her investment.*

The third hypothesis emphasizes that an endowment increase under EA (600-300) leads an investor to invest more than she does with less endowment (300-300). Since EA divides the survived value of the project equally among two members, if the project goes under, the wealthier investor has to share the remainings of her investment equally with the poorer investor. Therefore, although she raises her investment regarding her wealth increase, she is expected to invest less than the case both members have equal endowment (600-600).

The fourth hypothesis claims that even if one's endowment does not change, as the other group member is wealthier, she also increases her investment. This is because, under EA, the possible burden she carries in case of bankruptcy might decrease compared to other rules if the other investor invests more. Moreover, the other investor is expected to invest more when she has 600 (300-600) than 300 (300-300).

Hypothesis 5: *If an investor is wealthier than the other investor under EL, she reacts with an increase in her investment. The amount she invests as the richer one is greater than the amount she invests with the same endowment while her partner is equally wealthy.*

Hypothesis 6: *If an investor is poorer than the other investor under EL, she reacts with a decrease in her investment.*

Since the loss is equally shared among investors under EL, with an extra unit of investment, she makes her share from possible loss decline. The investor already invests more than the poorer due to an increase in her endowment, and there is an additional increase in her investment since she becomes advantageous to invest more than the other person. However, the additional increase fades if the two investors have high and equal endowments. H5 is tested by comparing investments in rounds 300-300, 600-300 and 600-600.

According to H6, even if an investor's wealth remains the same, if the other investor's wealth increases or she gets matched with a wealthier investor, she decreases her investment. This is checked by comparing rounds 300-300 and 300-600.

Hypothesis 7: *Among the bankruptcy rules, the order in terms of total investment is Equal Losses > Proportionality > Equal Awards, and this order applies to all different endowment pairs.*

2.2.1.3 Rounds

Stage 1 consists of a total of 12 independent decision-making rounds. In each round, two subjects, who were randomly and anonymously matched, decided how much to invest in a risky project. One's own endowment and the endowment of the other group member, the interest rate (r) in case the project is successful, the probability of success (p), the surviving fraction (β), the determined bankruptcy principle was shown to the subjects in the investment screen. They were also told that the points they did not decide to invest would be saved in their account and added to the project's revenue at the end of each round. It is important to note that in each of the 12 rounds, subjects made a fresh start, and the results of the previous rounds did not affect the setup of the following rounds.

Subjects were also provided a special calculator on the investment page to use if they request, which calculates the probable outcomes of investments based on the current bankruptcy rule and the p, β and r values. The frequency of using this program by the participants was recorded. At the end of each round, information about the investment levels of one and the person she was matched with in that round and one's or the other participant's tour earnings were not delivered. That is, subjects made their investment decisions in each round without knowing the results of the previous rounds. This design can be considered as a more "live" application of the frequently used strategy method, thanks to the fact that participants were actually matched in each round, but they were able to see the results of the rounds at the end of the experiment. The intention of constructing the method this way was to prevent previous results from forming an effect on proceeding rounds. This was a delicate matter since subjects faced unequal endowment matchings in some rounds. There were three blocks in this stage of the experiment.

2.2.1.4 Blocks

There were three blocks in total in the experiment. Each block consists of 4 decision-making rounds in which one of the PRO, EA and EL applies as bankruptcy rule. Each bankruptcy rule will be valid in only one block. Before each block starts, the valid bankruptcy rule and endowment allocations were explained to the participants in detail. Examples regarding the rules were shown and subjects took a quiz designed to reveal if the rule and the mechanism of blocks were understood.

The endowments in rounds in a block were as follows:

Table 2.2: Endowment Allocations

1st Round	(wi,wj)	(300,300)
2nd Round	(wi,wj)	(300,600)
3rd Round	(wi,wj)	(600,300)
4th Round	(wi,wj)	(600,600)

Subjects made an investment decision for the above-mentioned endowment allocations under each rule. Having an actual matching in each round divides subjects into two types. In the second round of each block, 300 points were allocated to one investor and 600 points to other investor. In the third round, the one with 300 points in the second round had 600 points and the other investor with 600 points in the second round had 300 points. Therefore, subjects needed to be classified according to the rounds they were richer/poorer in the group.

Type 1: Subjects who had 300 points in the second round and 600 points in the third round.

Type 2: Subjects who had 600 points in the second round and 300 points in the third round.

It is helpful to note that since the endowment allocations were announced prior to blocks, type differentiation would not significantly affect investments. The type of subject will not change during the session, meaning that she will have endowment allocations in the same order under all principles. In this way, the sequence of increase/decrease of individual wealth and the order of its relativity to the wealth of the other participant will be constant in each block on a participant basis.

The earnings of the subjects from Stage 1 were the sum of the returns obtained in one round randomly selected from each block (a total of three rounds). However, subjects learned about the randomly selected rounds and their returns from these rounds at the end of the experiment. This was in order to prevent earnings of this stage from affecting the decisions of later stages. Points earned in this stage converted to Turkish Lira with a ratio of 0.01. If randomly chosen rounds and the project's probabilistic outcome allows, a subject could earn 5400 points (54 TL) maximum.

2.2.2 Stage 2: Belief Elicitation

In the theoretical model, it is assumed that everyone has a DARA type utility function, and this is known by each agent. Sharing this information and asking investors to consider that the other investor behaves according to DARA would cause two problems. First of all, it would not be easy to explain the DARA utility function to subjects. The second one is that this piece of information might lead the decision-making process. Hence, subjects were asked to guess the investors' decisions they were matched with. In this way, each investor's assumptions about the utility function of others were matched.

For all three blocks (bankruptcy rules) in Stage 1, following question were asked:

In Stage 1, under ... bankruptcy rule, suppose an investor invested ”X” points when endowments were (300,300). What will be the other investor’s investment in case your endowment remains at 300 and her endowment is 600?

- Exactly ”X”
- More than ”X”
- Less than ”X”

If one’s guesses are ”More than ”X” for all three questions, she consistently assumes and expects that other investors behave according to DARA.

One of the three guessing questions answered will be drawn randomly. If the answer matches the other group member’s actual decision, 200 points will be awarded to incentivize this stage and raise attention. Points earned in this stage converted to Turkish Lira with a ratio of 0.01. Results of this stage were at the end of the experiment to prevent any return from this stage to create an effect in a later stage.

3

2.2.3 Stage 3: Risk Elicitation

The third stage consists of a dynamic portfolio allocation game that each subject attends individually. The methodology is from a portfolio optimization problem in Merton (1971) and used in an experiment by Brocas et al. (2019). The model in the dynamic portfolio allocation problem assumes exactly the same HARA utility function used in Chapter 1. As described in Stage 1, investors lie within various absolute and relative risk aversion classes for different values of γ and η. Especially for $\gamma < 1$, ($\gamma \neq 0$) it lies within DARA.

A 10-round dynamic portfolio allocation game that forms one block at this stage was repeated three times. In total, subjects made 30 decisions and completed three blocks. In the first round of each block, each subject was endowed with 500 points and asked to allocate her points between a risky and a risk-free asset. Results of the round, profit/loss and the current value of the portfolio were shown. In the second round, the endowment was the portfolio's total value in the first round. Following this, the endowment of the third round was the total value of the second round. Each round's endowments dynamically change, and the process continues up to the 10th round. The design enables us to observe the effects of endowment changes on risky investments. After each 10th round was completed, the next block started with 500 points in the first round.

The risk-free asset yields a 3% return, and the risky asset follows a lognormal distribution with a mean of 1.235 (23.5% profit) and standard deviation 0.734[5]. The following equation determines the wealth change:

$$X(t+1) = X_B(t)(1+r) + X_A(t)e^R,$$

where X_B represents the amount invested in a risk-free asset, $X_A(t)$ represents the amount of risky investment.

Parameter estimations for (γ, η) were made by regressing risky investment on variables that formulates the parameter values.

[5] Return of the risky asset is normally distributed with mean 0.06 and standard deviation 0.55. The reason lognormal distribution was used in determining the return of the risky asset was to prevent the multiplication factor from being negative.

$$\pi_{i,t} = aX_{i,t} + bF_{i,t} + u_{i,t},$$

where $\pi_{i,t}$ is the wealth allocated to the risky asset, $X_{i,t}$ is the current wealth and $F_t = e^{-r(T-t)}$ in each block i and each round t. Also, $a = \frac{\mu - r}{\sigma^2(1-\gamma)}$ and $b = \frac{(\mu - r)\eta}{\sigma^2}$ where μ, σ are parameter values from normal distribution of risky asset and r is return rate of risk-free asset. Finally, $u_{i,t} \sim \mathcal{N}(0, \sigma^{2S})$.

One of the three blocks is randomly selected, and the total portfolio value at the end of the 10th round was delivered to subjects. Points earned in this stage converted to Turkish Lira with a ratio of 0.01.

2.2.4 Questionnaire

After the three stages, subjects were asked to answer a questionnaire. It starts with a question that subjects self-reveal their risk appetite. From 0 to 10, they were asked how much they take risks. This question was followed by two questions; in one of them, subjects were asked to choose between a certain 475 TL and 2000 TL with 25% probability and 0 TL with 75% probability. In the second question, the options were a certain loss of 725 TL and a loss of 1000 TL with 75% probability and no loss with 25% probability.

As demographics, age, gender, the department they study, scholarship type, if there is a scholarship, and education levels of father and mother were asked. Also, it was asked if subjects had enrolled in another experiment before.

At the end of the questionnaire, the results of all three stages were shown. For Stage 1, the results of each of the 12 rounds were listed, stating the applied bankruptcy rule, investment of subject, total investment in the group, and the result of the project.

Below, the results of belief questions were placed. At the bottom, the final values of portfolios at the last round of three blocks were listed. Finally, below the results table, randomly chosen rounds from each stage to be paid were written with the amounts earned.

2.2.5 Implementation

Sessions of this experiment took place online due to measures of Covid-19. Subjects were recruited from the database of Bilgi Economics Lab of Istanbul (BELIS) through the Online Recruitment System for Economic Experiments Greiner (2015). ”oTree”, an open-source platform developed by Chen, Schonger, and Wickens (2016) was used to program experiments and conduct sessions. The language of the experiment was Turkish. Subjects logged in to the experiment via links randomly assigned to each of them. Links were not paired with any personal information to secure the anonymity of the decisions and participants.

The instructions of the experiment were read before each stage via Zoom meeting. It was told that there were three stages in total and each stage was explained just before it started. In total, 178 subjects participated in the experiment and there were 6 sessions. Each session differed in the order of bankruptcy rules (blocks) in Stage 1. In order to prevent an order effect, all six combinations of three rules (PRO, EA, EL) were applied in a total of 6 sessions. Information on sessions can be summarized in Table 2.3.

Table 2.3: Design of Sessions

# of Session	# of Subjects	Order of Rules
Session 1	28	PRO - EA - EL
Session 2	30	PRO - EL - EA
Session 3	30	EA - PRO - EL
Session 4	30	EA - EL - PRO
Session 5	30	EL - PRO - EA
Session 6	30	EL - EA - PRO

2.3 RESULTS

2.3.1 Survey

Data collected via survey reveals the participants' demographics and self-revealed risk preferences. The first question asked was, "How do you rate yourself from 0 to 10 on risk-taking?". 0 = "never takes risk" and ten = "definitely takes risk".The distribution of subjects on this matter is shown in Figure 2.1.

Subjects are almost equally distributed in terms of gender. The number of females is slightly greater than males. 94.6% of the subjects have at least a partial scholarship. Most of the subjects are from the Faculty of Engineering and Natural Sciences. Another exciting piece of information about participants enrolled in this experiment is that 82% of them participated in another experiment in BELIS.

In Question 1, more participants preferred a definite win of 475 TL while the expected outcome of the second option was 500, greater than the "definite" 475 TL. For Question 2, more than two-thirds of the participants chose the second option.

Figure 2.1: Self-assessed Risk Levels

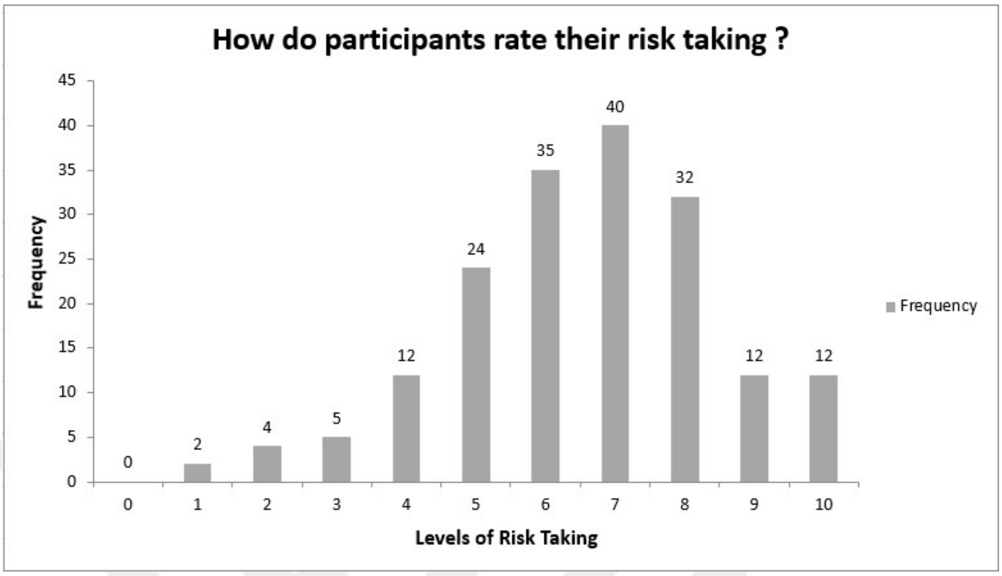


Table 2.4: Statistics from Survey

Gender	Female: 97 (54.5%)	Male: 81 (45.5%)
Scholarship	Full: 63 (35.4%)	Partial: 105 (59%)
	No scholarship: 10 (5.6%)	
Faculty	Engineering: 93 (52.2%)	Business: 42 (23.6%)
	Social Sciences: 20 (11.2%)	Law: 17 (9.6%)
	Architecture: 4 (2.2%)	Communication: 1 (0.6%)
	Sports Science: 1 (0.6%)	
Experiment Experience	Yes: 146 (82%)	No: 32 (18%)
Question 1	A definite win of 475 TL:	Winning 2000 TL with 25% probability, winning nothing with 75% probability:
	103 (57.9%)	75 (42.1%)
Question 2	A definite loss of 725 TL:	Losing 1000 TL with 75% probability, losing nothing with 25% probability:
	57 (32%)	121 (68%)

Although the expected loss in the second option is greater than the ”definite” loss scenario, more people wanted to go for a greater expected loss for the sake of a 25% chance of losing nothing.

2.3.2 Risk Elicitation

For each of the subjects, the regression described in 2.3 was estimated. Amount invested on the risky asset was regressed on wealth at that round and F_t. In total, there were 178 separate OLS estimates with 30 observations. The number of observations is smaller than they had Brocas et al. (2019), which highly likely causes higher standard errors. In return, it gets harder to find $X_{i,t}$ significant[6]. 10% is taken as the significance level rather than 5% to compensate for higher standard errors.

More than half of the estimations suffer heteroskedasticity, autocorrelation, or both. HAC (Heteroskedasticity and autocorrelation consistent) standard errors were used instead of default standard errors. The model cannot allow participants to take short position on the risky asset or borrow points; an agent's intentions on allocating 0 or maximum amount on the risky asset are unclear in that sense. As a result, subjects who hit constraints more than 6 rounds (20% of all rounds) were considered ”Constrained Subjects.”

[6] To prove a person is classified as DARA, $X_{i,t}$ should be a significant regressor. For CARA, as $\gamma_i \to \infty$ or $\gamma_i \to -\infty$, $a = \frac{\mu - r}{\sigma^2(1-\gamma)} \to 0$. So, if $X_{i,t}$ is not significant, the investor's behavior fits CARA.

There are 131 unconstrained subjects who were classified as follows:

Table 2.5: Distribution of Subjects - ARA

ARA Type	# of Subjects	Percentage
DARA	85	64.8%
CARA	39	29.7%
IARA	7	5.3%
TOTAL	131	100%

Table 2.5 shows 85 out of 131 unconstrained subjects are DARA. The percentage of DARA is 84% in Brocas et al. (2019). Although the percentage of DARA in this experiment is less than Brocas et al. (2019), we found that almost two-thirds of the participants fit DARA.

30 subjects fit the definition of ”Constrained Subjects”. There is also a unique scenario where both regressors are insignificant. As both regressors are insignificant, the suggested class of utility function is CARA-CRRA. These Absolute and Relative Risk Aversion classes cannot happen simultaneously. $CRRA$ indicates that the investor allocates the same percentage of her endowment to the risky asset no matter the endowment level. And $CARA$ tells the opposite by expecting the same nominal amount to be allocated to the risky asset for any endowment level. These subjects are labeled as ”Unknown”. The detailed distribution of classes is below:

Table 2.6: Distribution of Subjects - ARA-RRA Classes.

CLASS	# of Subjects	Percentage
DARA-DRRA	6	3.3%
DARA-CRRA	44	24.7%
DARA-IRRA	35	19.6%
IARA-IRRA	7	3.9%
CARA-IRRA	39	21.9%
Constrained	30	16.8%
Unknown	17	9.5%
Total	178	100%

Table 2.6 gives insight into the distribution of subjects in terms of RRA. More than half of the $DARA$ subjects are also $CRRA$. $IRRA$ follows with 41% of the DARA subjects. Including ”constrained” ones and ”unknowns,” 47.6% of the 178 participants are $DARA$. 24.7% of the subjects tend to keep the risky asset ratio on their portfolio. The percentage of investors who reduce the risky asset ratio is 19.6.

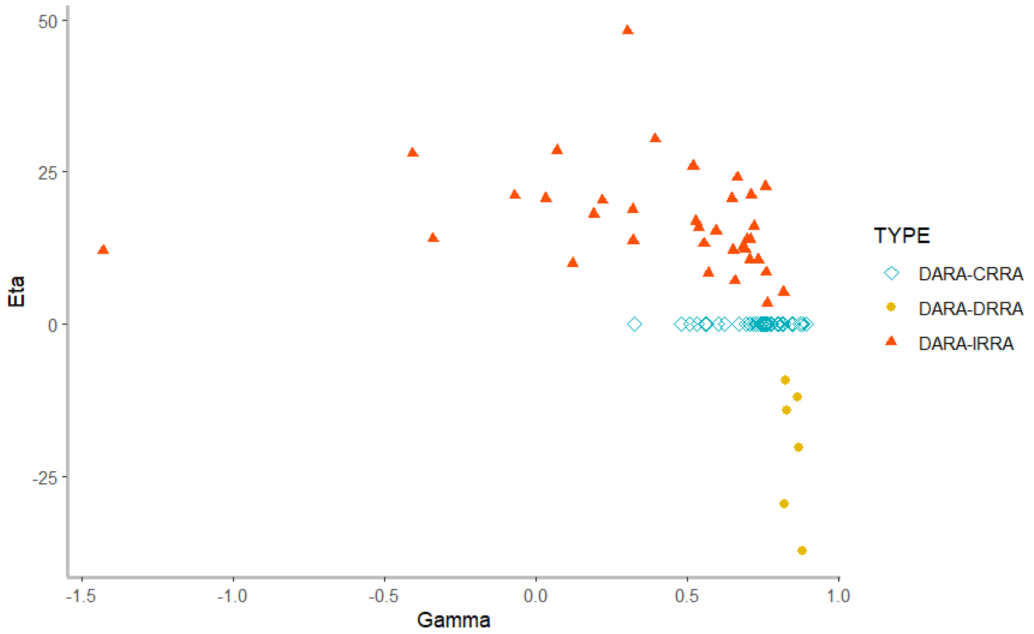
In Figure 2.2, the estimated values of the parameters, which belong to subjects classified in DARA, γ and η[7] are shown as divided into three subgroups. Increased, Constant and Relative Risk Aversion types are shaped and colored distinguishably.

2.3.2.1 Constrained Subjects

In order to analyze the risk aversion of the constrained subjects, Brocas et al. (2019) suggested a probit regression with two models.

[7] The values of η are divided by 100 to scale the scatter diagram. Since 500 points were endowed to subjects, η estimates were accordingly high. When we multiply the data by 0.01 and re-estimate, we achieve the same η values when we multiply estimated values by 0.01 as described.

Figure 2.2: Estimated Risk Aversion Parameters for 85 DARA Subjects



$$\pi_{i,t}^{max} = b_0^{max} + b_1^{max} w_{i,t} + \epsilon_{i,t}^{max}$$

$$\pi_{i,t}^{min} = b_0^{min} + b_1^{min} w_{i,t} + \epsilon_{i,t}^{min}$$

$\pi_{i,t}^{max}$ is equal to 1 when $\pi_{i,t} = w_{i,t}$ and 0 otherwise. $\pi_{i,t}^{min}$ is equal to 1 if $\pi_{i,t} = 0$ and 0 otherwise.

There are 3 classes that are identifiable through the results of these regressions. If $b_1^{max} < 0, b_1^{min} > 0$ or both, the subject is considered as Constrained IRRA. If $b_1^{max} > 0, b_1^{min} < 0$ or both, the subject is considered as Constrained DARA-DRRA. If both of the coefficients are insignificant, the subject is Constrained Irregular. The distribution of these 30 constrained investors was as in Table 2.7.

Table 2.7: Distribution of Constrained Subjects.

CLASS	# of Subjects	Percentage
Constrained IRRA	12	40%
Constrained DARA-DRRA	1	3.3%
Constrained Irregulars	17	56.6%
Total	30	100%

Also, the correlation of risk aversion classes of subjects and belief elicitation observations from stage 2 were analyzed. The analysis concluded as there was no correlation between investors' own decisions and guesses they made for their group members. The intention was to check if these guessing questions functioned as a mirror and show one's own decisions. Due to the fear of possible multicollinearity with the risk elicitation part and the fact that correlation values are not promising, data from the belief elicitation part were not included in the regression analysis in Section 2.4.3.

2.3.3 Investment Decisions

Individual investment decisions are summarized in Table 2.8. For each round under the 3 blocks, the average investment amount in points, standard errors, and investments in percentages are shown. According to the table, PRO and EL yield greater investment levels than EA in almost all rounds (endowment allocations).

Supporting Hypothesis 4, EA 2 is greater than EA 1, which means that when investors group with wealthier ones, they invest more regardless of their wealth is remained the same. The table also seems to support H3 as EA 4 is more than EA 3; while investors had equally 600 points to invest, their opponents had 600 and 300 points, respectively.

Table 2.8: Summary Statistics of Investment Decisions in Stage 1

	PRO 1	PRO 2	PRO 3	PRO 4
Mean	185.3 (6.5)	192.6 (6.7)	391.1 (12.8)	420.5 (12.2)
Percentage in Wealth	61.8%	64.2%	65.2%	70.1%
	EA 1	EA 2	EA 3	EA 4
Mean	170.6 (6.8)	191.9 (6.9)	360.4 (13.5)	378.1 (13.9)
Percentage in Wealth	56.9%	64%	60.1%	63%
	EL 1	EL 2	EL 3	EL 4
Mean	187.2 (7.2)	190.5 (7.1)	399.9 (14.2)	414.6 (13.5)
Percentage in Wealth	62.4%	63.5%	66.7%	69.1%

[a] Each number a rule stands for the order of the endowment allocations. For example, 1 is the first round where all group members have 300 points. 2 represents the amount invested by each investor when she had 300 points versus 600 points. The opposite scenario is valid for 3; each investor had 600 points in 4.
[b] Standard errors are in parentheses and n = 178.

To check whether there is evidence confirming hypotheses 1 and 2, paired t-tests comparing individual investments of 85 DARA subjects are presented in Table 2.9.[8] Null and alternative hypotheses of these tests were formed according to the hypotheses in subsection 2.2.1.2 and prior to test results.

[8] When these tests were made for all 178 subjects, they conclude with same results. Only p-values differ.

According to Hypothesis 1, subjects ought to invest more when they have greater wealth, regardless of the opponent's wealth. In terms of that, there is strong evidence that investments in the third round are greater than in the first round (PRO3 > PRO1), (PRO4 > PRO1), (PRO3 > PRO2), and (PRO4 > PRO2). For Hypothesis 2, since the players' investment does not affect each other's payoff under PRO, the desired outcome is not to see any significant difference between the rounds where the investor's wealth remains the same. Therefore, there is no significant difference between amounts invested in the first two rounds (PRO1-PRO2). However, the test for PRO3-PRO4 fails on not rejecting the null hypothesis.

Table 2.9: Paired T-tests for PRO.

	p-value	Hypothesis	Comments
PRO1-PRO2	0.67	$H_0 : PRO1 = PRO2$	Supports H2
PRO1-PRO3	0.00	$H_0 : PRO1 \geq PRO3$	Supports H1
PRO1-PRO4	0.00	$H_0 : PRO1 \geq PRO4$	Supports H1
PRO2-PRO3	0.00	$H_0 : PRO2 \geq PRO3$	Supports H1
PRO2-PRO4	0.00	$H_0 : PRO2 \geq PRO4$	Supports H1
PRO3-PRO4	0.01	$H_0 : PRO3 = PRO4$	Does not support H2

[a] e.g., PRO1-PRO4 means the comparison of individual investments made in the first and fourth rounds of PRO. For example, PRO2 is the round where each subject had 300 points against another investor who has 600 points. PRO3 is the round where the endowment allocation was (600-300).

Table 2.10: Paired T-tests for EA.

	p-value	Hypothesis	Comments
EA1-EA2	0.038	$H_0 : EA1 \geq EA2$	Supports H4
EA1-EA3	0.00	$H_0 : EA1 \geq EA3$	Supports H3
EA1-EA4	0.00	$H_0 : EA1 \geq EA4$	Supports H3
EA2-EA3	0.00	$H_0 : EA2 \geq EA3$	Supports H3
EA2-EA4	0.00	$H_0 : EA2 \geq EA4$	Supports H3
EA3-EA4	0.055	$H_0 : EA3 \geq EA4$	Supports H3

According to the results in Table 2.10, for the first part of Hypothesis 3, tests support that when one has a greater wealth, she invests more. This can be supported with tests (EA1-EA3), (EA1-EA4), (EA2-EA3), and (EA2-EA4). The second part claims that EA4 should be greater than EA3. The null hypothesis is rejected at the 10% significance level, suggesting that agents with 600 points invest less when the other investor has 300 points, compared to the case when they have 600 points.

EA1-EA2 tests for an increase in investment when other investor's wealth changes. And it rejects the null hypothesis of EA1 being equal to EA2. Thanks to the effect of other investor's wealth, even if one's wealth remains the same, she invests more in EA2.

Paired t-tests placed in Table 2.11 are to test Hypotheses 5 and 6. According to Hypothesis 5, investors would invest in the round (600-300) more than (600-600).

Table 2.11: Paired T-tests for EL.

	p-value	Hypothesis	Comments
EL1-EL2	0.339	$H_0 : EL1 \leq EL2$	Does not support H6
EL1-EL3	0.00	$H_0 : EL1 \geq EL3$	Supports H5
EL1-EL4	0.00	$H_0 : EL1 \geq EL4$	Supports H5
EL2-EL3	0.00	$H_0 : EL2 \geq EL3$	Supports H5
EL2-EL4	0.00	$H_0 : EL2 \geq EL4$	Supports H5
EL3-EL4	0.846	$H_0 : EL3 \leq EL4$	Does not support H5

The reason for that is sharing the potential burden of a loss equally while being in an advantageous position as having more points. And when parts are equally wealthy as in round (600-600), this advantage of being richer vanishes. Hypothesis 5 also claims that if one becomes wealthier, she would invest more than before. Test of (EL3-EL4) cannot reject the H_0, which means the effect discussed in the first sentence was not significant according to paired t-test. (EL1-EL3), (EL1-EL4), (EL2-EL3), and (EL2-EL4) reject H_0 and support the part of Hypothesis 5 on an investor's own wealth.

For Hypothesis 6 to be supported, EL2 should have been less than EL1. Since H_0 is not rejected, Hypothesis 6 cannot be supported by paired t-test.

Investment groups were randomly formed in each round, and there were no previously created sub-groups regarding the risk aversion types. Therefore, a DARA participant could be matched with a CARA or even UNKNOWN type. This makes it impossible to clarify group-level investments for DARA subjects, both in parametric tests and regressions. Instead of using group-level investment data, individual investments were compared across rules and rounds to test Hypothesis 7. Except for investments of round (300-600), paired t-tests suggest an order between rules as EL = PRO > EA, according to Table 2.12.

Table 2.12: Paired T-tests for comparison of rules.

	p-value	Hypothesis	Comments
PRO1-EA1	0.020	$H_0 : PRO1 \leq EA1$	Supports H7
PRO1-EL1	0.534	$H_0 : PRO1 \geq EL1$	Does not support H7
EA1-EL1	0.063	$H_0 : EA1 \geq EL1$	Supports H7
PRO2-EA2	0.311	$H_0 : PRO2 \leq EA2$	Does not support H7
PRO2-EL2	0.791	$H_0 : PRO2 \geq EL2$	Does not support H7
EA2-EL2	0.616	$H_0 : EA2 \geq EL2$	Does not support H7
PRO3-EA3	0.008	$H_0 : PRO3 \leq EA3$	Supports H7
PRO3-EL3	0.352	$H_0 : PRO3 \geq EL3$	Does not support H7
EA3-EL3	0.016	$H_0 : EA3 \geq EL3$	Supports H7
PRO4-EA4	0.004	$H_0 : PRO4 \leq EA4$	Supports H7
PRO4-EL4	0.729	$H_0 : PRO4 \geq EL4$	Does not support H7
EA4-EL4	0.018	$H_0 : EA4 \geq EL4$	Supports H7

Analysis of investment decisions continues with Random Effect Tobit Regression. In order to handle unobserved session level factors, the random effects model considers the session differences as random disturbances.

Table 2.13: Estimations of Random Effect Tobit Regressions on Individual Investment

Individual Investment is Regressed on Variables Below

	Reg. 1: All Risk Types		Reg. 2: DARA Only	
PRO (300-600)	9.47	(0.43)	16.15	(0.59)
PRO (600-300)	191.53***	(8.77)	201.6***	(7.44)
PRO (600-600)	236.61***	(10.77)	247.2***	(9.06)
EA (300-300)	-29.40	(-1.34)	-30.96	(-1.14)
EA (300-600)	14.19	(0.64)	5.74	(0.21)
EA (600-300)	152.07***	(6.98)	149.0***	(5.53)
EA (600-600)	178.51***	(8.16)	187.4***	(6.91)
EL (300-300)	4.02	(0.18)	2.54	(0.09)
EL (300-600)	3.38	(0.15)	-4.92	(-0.18)
EL (600-300)	210.76***	(9.60)	209.9***	(7.73)
EL (600-600)	229.54***	(10.42)	232.2***	(8.51)
CARA	-35.03***	(-3.48)		
IARA	-20.36	(-0.97)		
Gender	46.41***	(4.54)	48.25***	(4.01)
Quiz	7.96	(0.75)	14.60	(1.08)
Calculator	28.34***	(3.05)	47.55***	(4.07)
Type	-0.70	(-0.08)	-11.45	(-1.02)
Constant	176.61***	(24.84)	172.8***	(5.37)
sigma_u	18.78**	(2.46)	31.90**	(2.88)
sigma_e	171.90***	(44.84)	170.9***	(35.66)
Observations		1572		1020

t statistics in parentheses

$^{*}p < 0.10, ^{**} p < 0.05, ^{***} p < 0.01$

OLS regressions with clustered robust standard errors and same specifications were placed in Appendix B.

Each subject creates 12 observations. Including unconstrained subjects with a defined risk aversion type, it makes 1572 observations for Regression 1. PRO (300-600), PRO (600-300),..., and EL (600-600) are dummy variables that take value 1 if the observation is from that specific round. For example, if EL (300-600) equals 1, the investment was made under EL, and endowment allocations were 300 to the investor herself and 600 to other investor. CARA and IARA are the dummy variables for the risk aversion type of the subject who created the observation. Gender equals 1 if the subject is male and 0 otherwise. The Quiz is defined in order to include the effect of whether subjects understood the employed bankruptcy rule or not. If participants give accurate answers to 2 or more out of 3 questions, Quiz takes value 1, and 0 otherwise. The Calculator is the variable stating if the subjects used the calculator in that specific round while making an investment decision. It is equal to 1 if one uses the calculator and 0 otherwise. Finally, Type is included to check whether the order of seeing (300-600) and (600-300) endowments has a significance on investment decisions or not.

The reference category in the model is the missing round on the equation (PRO (300-300)), DARA, Female, no quiz success, no calculator usage, and type 2.

Explanatory variables and reference category almost remain the same for Reg. 2. The only difference is that CARA and IARA subjects were excluded from the dataset. Theoretically, CARA subjects do not make investment regarding their wealth. Hence, they are expected to invest the same amount in all rounds. Therefore, in order to satisfy theoretical predictions, the estimated investment for CARA in Reg. 1 should be the same for all endowment dummies. Although this is impossible to achieve, individual investments should be regressed as in Reg. 1 to see the effects of CARA and IARA. For a more specific examination, Reg. 2 only includes DARA subjects.

Hypothesis 1: PRO (600-300) and PRO (600-600) are both extremely significant in both regressions, so Hypothesis 1 finds support. To conclude with this result, Wald test for coefficients with null hypotheses of "PRO (300-600) ≥ PRO (600-300)" and "PRO (300-600) ≥ PRO (600-600)". These tests reject H_0 with a p-value close to 0 in both regressions.

Hypothesis 2: To support Hypothesis 2, there should not be any significant difference between PRO (300-600) and PRO (300-300), which is the reference. Also, the equality of PRO (600-300) and PRO (600-600) should be checked. In both regressions coefficient of PRO (300-600) is not significant. However, $H_0 : PRO(600 - 300) = PRO(600 - 600)$ is rejected at 5% both in Reg. 1 and 10% in Reg. 2.

Hypohesis 3: The first part of Hypothesis 3 is supported by the test results from 1 to 4 in Table 2.14. In all of the tests, the p-values are so close to 0. Test 5 is suitable for the second part, and it rejects H_0 in Reg. 2 at 10%, but Reg. 2 cannot support the hypothesis as it does not reject H_0 of Test 5. According to these results, DARA subjects invest more when they are equally wealthy (600-600) compared to when one part has less wealth (600-300).

Table 2.14: P-values of the Coefficient Tests for Hypotheses 3-4.

	The Null Hypotheses	Reg. 1	Reg. 2
1	$H_0 : EA(300-300) \geq EA(600-600)$	0.00	0.00
2	$H_0 : EA(300-300) \geq EA(600-300)$	0.00	0.00
3	$H_0 : EA(300-600) \geq EA(600-600)$	0.00	0.00
4	$H_0 : EA(300-600) \geq EA(600-300)$	0.00	0.00
5	$H_0 : EA(600-300) \geq EA(600-600)$	0.11	0.076
6	$H_0 : EA(300-300) \geq EA(300-600)$	0.023	0.089

Hypothesis 4: In table 2.14, Test 6 supports Hypothesis 4 as a test for the coefficients of Reg. 1 rejects H_0 at 5% and Reg. 2 at 10%. One can say that investors relax and increase their investment even if they remain with the same wealth but get matched with wealthier ones.

Hypothesis 5: To test the first part of the hypothesis, Wald tests from 1 to 4 are used in Table 2.15. As all the tests reject H_0 at a very significant level, it can be inferred that investments increase with wealth.
For the second part, Test 5 does not reject H_0 and cannot support that part of the hypothesis.

Hypothesis 6: Both regression estimations fail to support Hypothesis 6 as Test 6 in Table 2.15 cannot reject the null hypothesis. So, we cannot say that when one faces a wealthier group member, she invests less than she does at (300-300).

Table 2.15: **P-values of the Coefficient Tests for Hypotheses 5-6.**

		Reg. 1	Reg. 2
1	$H_0 : EL(300-300) \geq EL(600-600)$	0.00	0.00
2	$H_0 : EL(300-300) \geq EL(600-300)$	0.00	0.00
3	$H_0 : EL(300-600) \geq EL(600-600)$	0.00	0.00
4	$H_0 : EL(300-600) \geq EL(600-300)$	0.00	0.00
5	$H_0 : EL(600-300) \leq EL(600-600)$	0.20	0.20
6	$H_0 : EL(300-300) \leq EL(300-600)$	0.48	0.39

Hypothesis 7: Comparison of the investments under different bankruptcy rules is made with the tests stated in Table 2.16.

Both regressions did not find a significant difference between rules in rounds (300-300) and (300-600). Tests failed to reject H_0 even in 10% except Test 3 at Reg. 1. One may say there is a different scenario for the rest two rounds (600-300) and (600-600). From Tests 7 to 12, both regressions test results conclude that PRO and EL induce greater investment than EA. P-values of the Tests 8 and 11 suggest that PRO might be greater than or equal to EL. Although the hypotheses were constructed as one-sided thanks to the results of Chapter 1, results should not be considered as PRO > EL. Moreover, we can say they are not significantly different. Aside from the effect of endowment allocations, Gender and the amount calculator used are found to be highly significant. As suspected and discussed previously, Type did not result as a significant variable in explaining investment levels.

Table 2.16: P-values of the Coefficient Tests for Hypothesis 7.

	The Null Hypotheses	Reg. 1	Reg. 2
1	$H_0 : PRO(300-300) \leq EA(300-300)$	0.089	0.125
2	$H_0 : PRO(300-300) \geq EL(300-300)$	0.43	0.46
3	$H_0 : EA(300-300) \geq EL(300-300)$	0.069	0.11
4	$H_0 : PRO(300-600) \leq EA(300-600)$	0.42	0.35
5	$H_0 : PRO(300-600) \geq EL(300-600)$	0.36	0.22
6	$H_0 : EA(300-600) \geq EL(300-600)$	0.32	0.35
7	$H_0 : PRO(600-300) \leq EA(600-300)$	0.034	0.025
8	$H_0 : PRO(600-300) \geq EL(600-300)$	0.19	0.38
9	$H_0 : EA(600-300) \geq EL(600-300)$	0.00	0.012
10	$H_0 : PRO(600-600) \leq EA(600-600)$	0.00	0.014
11	$H_0 : PRO(600-600) \geq EL(600-600)$	0.37	0.28
12	$H_0 : EA(600-600) \geq EL(600-600)$	0.019	0.049

CONCLUSION

The aim of Chapter 2 was to measure the effect of one's own wealth, the wealth of other investors, and bankruptcy rules on an agent's decision-making process. The findings of the theoretical model in Chapter 1 was tested through the experiment. The model in Chapter 1 is built on the DARA assumption. Since subjects might vary on risk aversion types, theoretical predictions had to be tested in two separate groups; DARA subjects and all types of subjects.

Due to the fact that risk aversion types mattered, a complex risk elicitation method was used to classify subjects. The risk elicitation analysis found consistent results compared to the findings of the previous studies such as Brocas et al. (2019). DARA is the prominent risk aversion class. Among other variables, the risk aversion classification of subjects was used as an explanatory variable for analyses of investment decisions.

A result from Chapter 1 is that an investor invests more when she gets wealthier. This found behavioral evidence via the comparison of rounds that subjects had 300 points versus 600 points, both in the tests with DARA subjects and with all subjects. Under PRO, the theoretical framework suggests that an investor is only affected by her own wealth. Except for comparing the (600-300) and (600-600) behaviour of subjects fit the suggestion.

For EA, all of the paired t-tests for both groups of subjects (DARA subjects and all type of subjects) and the coefficient tests from the Reg 1 and Reg 2 supports the theory's predictions, except for one coefficient test in regressions; EA is the rule with the best fit. As a result, both DARA only subjects and all type of subjects increased investments according to their own wealth changes, and reacted to the wealth changes of their group members. Under EL, the effect of others' wealth was not present. The only reactions (increase/decrease) were to one's own wealth change.

Moreover, in the comparison between rules, PRO and EL managed to get ahead of EA. According to theoretical predictions, EL was supposed to yield more investment than PRO. However, both regressions and paired t-tests did not find EL as the greatest rule in terms of investment amounts. Gender had an extreme significance in both regressions.

One of the most important outcome of this chapter is that results explained above are not limited to DARA subjects. Through the evidences based on the behaviours of the subjects, some of the theoretical predictions might be relaxed from DARA assumption. This can also guide the further research possibilities of the theoretical model, as risk aversion type of the subjects might be inspected in a broader perspective.

The experiment was conducted with subjects, and investment decisions were analyzed with the data collected from individuals. Although the frame of the experiment concerned the individual investment in a risky project, the setup can be equivalent to the corporate dimension. At the end of the day, it is "subejcts" who manage the companies.

Furthermore, the parameters of the model of the investment game might have an impact on investment. If the experiment had been repeated with different p, β values, their effects might have been measured.[9]

[9] For an extensive version of the experiment with various values of parameters, there is an ongoing project of Assoc. Prof. Ayça Ebru Giritligil and Assoc. Prof. Emin Karagözoğlu supported by Scientific and Technological Research Council of Turkey (TUBITAK) with project code 122K016.

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APPENDIX A

Proof [**Proposition 1**] For each agent $i \in N$, $PRO_i(s) = \beta s_i$.

Return in case of success: $(w_i - s_i) + (1+r)s_i) = w_i + rs_i$

Return in case of bankruptcy: $(w_i - s_i) + \beta s_i = w_i + (1-\beta)s_i$

$$U_i^{PRO}(s) = p\frac{1-\gamma_i}{\gamma_i}\left(\frac{w_i+rs_i}{1-\gamma_i}\right)^{\gamma_i} + (1-p)\frac{1-\gamma_i}{\gamma_i}\left(\frac{w_i-(1-\beta)s_i}{1-\gamma_i}\right)^{\gamma_i}$$

by applying unconstrained maximization, we get:

$$pr\left(\frac{w_i+rs_i}{1-\gamma_i}\right)^{\gamma_i-1} = (1-p)(1-\beta)\left(\frac{w_i-(1-\beta)s_i}{1-\gamma_i}\right)^{\gamma_i-1}$$

$$\frac{pr}{(1-p)(1-\beta)} = \left(\frac{w_i-(1-\beta)s_i}{w_i+rs_i}\right)^{\gamma_i-1}$$

Let $A_i = \left[\frac{pr}{(1-p)(1-\beta)}\right]^{\frac{1}{\gamma_i-1}}$

Then $A_i = \frac{w_i-(1-\beta)s_i}{w_i+rs_i}$

$$BR_i(s_{-i}) = \frac{[1-A_i](w_i)}{(A_i r+(1-\beta))}$$

The above expression is achieved by first-order conditions.

$$BR_i(s_{-i}) = \frac{\left(1-\left[\frac{pr}{(1-p)(1-\beta)}\right]^{\frac{1}{\gamma_i-1}}\right)(w_i)}{\left[\frac{pr}{(1-p)(1-\beta)}\right]^{\frac{1}{\gamma_i-1}}r+(1-\beta)}$$

The denominator of the equilibrium investment is positive where $A_i > 0$. w_i , r and $(1-\beta)$ are already positive.

So the last expression for s_i to be positive is $1 - A_i > 0$. This can be transformed to $1 > \left[\frac{pr}{(1-p)(1-\beta)}\right]^{\frac{1}{\gamma_i - 1}}$. Since in our model $\gamma_i < 1$, the power of the right hand side is smaller than 1. The inequality reduces to $pr > (1-p)(1-\beta)$.$\square$

Proof [**Proposition 2**] PRO is the same principle as specified above. For each agent $i \in N$, $PRO_i(s) = \beta s_i$. Equal Awards (EA) can be described as a principle, dividing the survived amount of money equally amongst agents. For each agent $i \in N$, $EA_i(s) = \frac{\beta}{n}\sum_N s_i$ in case of bankruptcy.

Now for $AP[\alpha]$, when dividing the bankrupt value, proportionality rule is weighted with α, and the Equal Awards principle is weighted with $(1-\alpha)$. The way of dividing the amount in case of success remains the same, pure PRO.

Return in case of success: $(w_i - s_i) + (1+r)s_i = w_i + rs_i$

Return in case of bankruptcy: $(w_i - s_i) + \alpha\beta s_i + (1-\alpha)\frac{\beta}{n}\sum_N s_i$

$= w_i + \frac{(\beta + (n-1)\alpha\beta - n)}{n} s_i + (1-\alpha)\frac{\beta}{n}\sum_{N-i} s_j$

$$U_i^{AP[\alpha]}(s) = p\frac{1-\gamma_i}{\gamma_i}\left(\frac{w_i + rs_i}{1-\gamma_i}\right)^{\gamma_i} + (1-p)\frac{1-\gamma_i}{\gamma_i}\left(\frac{w_i + \frac{(\beta+(n-1)\alpha\beta-n)}{n}s_i + (1-\alpha)\frac{\beta}{n}\sum_{N-i}s_j}{1-\gamma_i}\right)^{\gamma_i}$$

by applying unconstrained maximization, we get:

$$pr\left(\frac{w_i + rs_i}{1-\gamma_i}\right)^{\gamma_i - 1} = (1-p)\left(\frac{n-\beta-(n-1)\alpha\beta}{n}\right)\left(\frac{w_i + \frac{(\beta+(n-1)\alpha\beta-n)}{n}s_i + (1-\alpha)\frac{\beta}{n}\sum_{N-i}s_j}{1-\gamma_i}\right)^{\gamma_i - 1}$$

$$\frac{npr}{(1-p)(n-\beta-(n-1)\alpha\beta)} = \left(\frac{w_i + \frac{(\beta+(n-1)\alpha\beta-n)}{n}s_i + (1-\alpha)\frac{\beta}{n}\sum_{N-i}s_j}{w_i + rs_i}\right)^{\gamma_i - 1}$$

Let $A_i = \left[\frac{npr}{(1-p)(n-\beta-(n-1)\alpha\beta)}\right]^{\frac{1}{\gamma_i - 1}}$

Then $A_i = \left(\frac{w_i + \frac{(\beta+(n-1)\alpha\beta-n)}{n} s_i + (1-\alpha)\frac{\beta}{n}\sum_{N-i} s_j}{w_i + r s_i} \right)$

$BR_i(s_{-i}) = \frac{(1-A_i)(w_i)+(1-\alpha)\frac{\beta}{n}\sum_{N-i} s_j}{\left(A_i r + \frac{n-\beta-(n-1)\alpha\beta}{n}\right)}$

Let $B_i = (1 - A_i)(w_i)$,

$C = (1-\alpha)\frac{\beta}{n}$,

$D_i = A_i r + \left(\frac{n-\beta-(n-1)\alpha\beta}{n}\right)$

$BR_i(s_{-i}) = \frac{B_i + C(S-s_i)}{D_i}$ where $S = \sum_N s_i$

Let $F_i = D_i + C$,

$BR_i(s_{-i}) = \frac{B_i + CS}{F_i}$

Solving this will give us:

$s_1^* = \frac{B_1+CS}{F_1}$
$+ \quad . \qquad\qquad .$
$+ \quad . \qquad\qquad .$
$+ \quad s_n^* = \frac{B_n+CS}{F_n} =$
$S = \frac{\left(\prod_{N-i} F_j\right)(B_i+CS)+\ldots+\left(\prod_{N-n} F_j\right)(B_n+CS)}{\prod_N F_i}$
$S = \frac{\sum_N \left[B_i \prod_{N-i} F_j\right]}{\prod_N F_i - C\sum_N\left[\prod_{N-i} F_j\right]}$ and by s_i^*'s formula, we have
$s_i^* = \frac{B_i+CS}{F_i}$.
The next step is replacing S inside the s_i^*. And the s_i^* becomes:
$s_i^* = \frac{B_i\left(\prod_N F_i - C\sum_N\left[\prod_{N-i} F_j\right]\right)+C\sum_N\left[B_i\prod_{N-i} F_j\right]}{F_i\left(\prod_N F_i - C\sum_N\left[\prod_{N-i} F_j\right]\right)}$

The expression which appears at the end of this process is the unique solution to the system $\{BR_i(s_{-i}) = s_i | i \in N\}$:

$$s_i^* = \frac{(1-A_i)(w_i)\left(\prod_N (A_i r + (1-\alpha\beta)) - C\sum_N \left[\prod_{N_{-i}} (A_i r + (1-\alpha\beta))\right]\right) + C\sum_N \left[(1-A_i)(w_i)\prod_{N_{-i}} (A_i r + (1-\alpha\beta))\right]}{(A_i r + (1-\alpha\beta))\left(\prod_N (A_i r + (1-\alpha\beta)) - C\sum_N \left[\prod_{N_{-i}} (A_i r + (1-\alpha\beta))\right]\right)}$$

Breaking down this expression, w_i is positive by definitions of w_i in this model. $\left(\prod_N (A_i r + (1-\alpha\beta)) - C\sum_N \left[\prod_{N\backslash i} (A_i r + (1-\alpha\beta))\right]\right) > 0$ has to be satisfied. $A_i = \left[\frac{npr}{(1-p)(n-\beta-(n-1)\alpha\beta)}\right]^{\frac{1}{\gamma_i - 1}}$ is positive for any values of n, β, α, p, and γ_i defined in the model.

The last part in the nominator; $+C\sum_N \left[(1-A_i)(w_i)\prod_{N-i}(A_i r + (1-\alpha\beta))\right]$ is positive conditional on $1 - A_i > 0$ since C, w_i, and $\prod_{N-i}(A_i r + (1-\alpha\beta))$ are already positive. Both expressions in the denominator have been examined before and stated as positive. Therefore, s_i^* being positive is conditional on the expression $1 - A_i$ is positive or not.

$1 - A_i = 1 - \left[\frac{npr}{(1-p)(n-\beta-(n-1)\alpha\beta)}\right]^{\frac{1}{\gamma_i - 1}}$

$1 - A_i > 0$ means $1 > A_i$ so,

$1 > \left[\frac{npr}{(1-p)(n-\beta-(n-1)\alpha\beta)}\right]$

Since $\gamma_i < 1$ this makes the denominator of the power and the power negative. We can convert it to
$1 > \left[\frac{(1-p)(n-\beta-(n-1)\alpha\beta)}{npr}\right]^{\frac{1}{1-\gamma_i}}$.

Now if we take $1 - \gamma_i$ power of the both sides the inequality reduces to

$pr > (1-p)\frac{(n-\beta-(n-1)\alpha\beta)}{n}$.$\square$

Proof [**Proposition 3**] Under EL, $EL_i(s) = s_i - \frac{(1-\beta)}{n}\sum_N s_i$.

$LP[\alpha]$ is a mixture of PRO and EL rules, with weights α and $(1-\alpha)$ respectively. $LP[\alpha]_i(s^*)$ denotes the exact return of investing s^*. The way of dividing the amount in case of success remains the same, pure PRO.

Return in case of success: $(w_i - s_i) + (1+r)s_i = w_i + rs_i$

Return in case of bankruptcy: $w_i - \alpha(1-\beta)s_i - (1-\alpha)\frac{(1-\beta)}{n}\sum_N s_i$

$= w_i + \frac{(\beta-1)(1+(n-1)\alpha)}{n}s_i - (1-\alpha)\frac{(1-\beta)}{n}\sum_{N_{-i}} s_j$

$U_i^{LP[\alpha]}(s) = p\frac{1-\gamma_i}{\gamma_i}(\frac{w_i+rs_i}{1-\gamma_i}+\eta_i)^{\gamma_i}+(1-p)\frac{1-\gamma_i}{\gamma_i}(\frac{w_i+\frac{(\beta-1)(1+(n-1)\alpha)}{n}s_i-\frac{(1-\alpha)(1-\beta)}{n}\sum_{N_{-i}}s_j}{1-\gamma_i}+ \eta_i)^{\gamma_i}$

by applying unconstrained maximization, we get:

$$pr\left(\frac{w_i+rs_i}{1-\gamma_i}\right)^{\gamma_i-1} = (1-p)\left[\frac{(1-\beta)(1+(n-1)\alpha)}{n}\right] (\frac{w_i - \frac{(1-\beta)(1+(n-1)\alpha)}{n}s_i - \frac{(1-\alpha)(1-\beta)}{n}\sum_{N_{-i}}s_j}{1-\gamma_i})^{\gamma_i-1} \quad (2)$$

$\frac{npr}{(1-p)(1-\beta)(1+(n-1)\alpha)} = \left(\frac{w_i-\frac{(1-\beta)(1+(n-1)\alpha)}{n}s_i-\frac{(1-\alpha)(1-\beta)}{n}\sum_{N_{-i}}s_j}{w_i+rs_i}\right)^{\gamma_i-1}$

Let $A_i = \left[\frac{npr}{(1-p)(1-\beta)[1+(n-1)\alpha)]}\right]^{\frac{1}{\gamma_i-1}}$

Then $A_i = \left(\frac{w_i-\frac{(1-\beta)(1+(n-1)\alpha)}{n}s_i-\frac{(1-\alpha)(1-\beta)}{n}\sum_{N_{-i}}s_j}{w_i+rs_i}\right)$

$$BR_i(s_{-i}) = \frac{(1-A_i)(w_i)-\frac{(1-\alpha)(1-\beta)}{n}\sum_{N_{-i}}s_j}{\left(A_ir+\frac{(1-\beta)(1+(n-1)\alpha)}{n}\right)}$$

Since $\frac{(1-\alpha)(1-\beta)}{n} > 0$, $w_i > 0$ and $(A_i r + \frac{(1-\beta)(1+(n-1)\alpha)}{n}) > 0$ by A_i being positive. So if $(1 - A_i) < 0$ everyone's best response and optimal investment level would be equal to 0.

If $(1-A_i) > 0$, to a k amount of agents $(1, ..., k)$ might have best response functions $BR_i(s_{-i}) > 0$. $1 - A_i$ being positive is examined in the previous rule too. But this time $(1 - A_i) = 1 - \left[\frac{npr}{(1-p)(1-\beta)(1+(n-1)\alpha))}\right]^{\frac{1}{\gamma_i - 1}}$. As in the similar exercise in EA-PRO, $1 - A_i > 0$ reduces to $pr > (1 - p)\frac{(1-\beta)(1+(n-1)\alpha)}{n}$. We could explain the left-hand side as the return on unit investment when the firm succeeds, the right-hand side as the loss agents face in the case of bankruptcy.
Agents from $k + 1$ to n will face $s_i^* = 0$ as an optimal investment level, because the 2^{nd} term in the nominator is subtracted from the first term and for some agents this makes the investment level negative.This order assumption of best response functions, $b_1 \geq ... \geq b_k > 0 = b_{k+1} = ... = b_n$, can be done thanks to the assumption of $\gamma_1 \geq ... \geq \gamma_n$.

Let $B_i = (1-A_i)(w_i)$, $C = \frac{(1-\alpha)(1-\beta)}{n}$, $D_i = A_i r + \left(\frac{(1-\beta)(1+(n-1)\alpha)}{n}\right)$, $BR_i(s_{-i}) = \frac{B_i - C(S - s_i)}{D_i}$ where $S = \sum_N s_i$.

Let $F_i = D_i - C$, $BR_i(s_{-i}) = \frac{B_i - CS}{F_i}$

Solving this will give us:

$s_1^* = \frac{B_1 - CS}{F_1}$

$+ \quad . \qquad\qquad .$

$+ \quad . \qquad\qquad .$

$+ \quad s_k^* = \frac{B_k - CS}{F_k} =$

$S = \frac{(\prod_{\{1,...,k\}\setminus\{i\}} F_j)(B_i - CS) + ... + (\prod_{\{1,...,k\}\setminus\{i\}} F_j)(B_n - CS)}{\prod_k F_i}$

$S = \frac{\sum_k \left(B_i \prod_{\{1,...,k\}\setminus\{i\}} F_j\right)}{\prod_k F_i + C \sum_k \left(\prod_{\{1,...,k\}\setminus\{i\}} F_j\right)}$ and by s_i^*'s formula, we have

$s_i^* = \frac{B_i - CS}{F_i}$.

The next step is replacing S inside the s_i^*. And the s_i^* becomes:

$s_i^* = \frac{B_i(\prod_k F_i + C\sum_k[\prod_{\{1,\ldots,k\}\setminus\{i\}} F_j]) - C\sum_k[B_i \prod_{\{1,\ldots,k\}\setminus\{i\}} F_j]}{F_i[\prod_k F_i + C\sum_k(\prod_{\{1,\ldots,k\}\setminus\{i\}} F_j)]}$

The expression which appears at the end of this process is the unique solution to the system

$\{BR_i(s_{-i}) = s_i | i \in N\}$=

$$s_i^* = \frac{(1-A_i)(w_i)\left[\prod_k (A_i r + (1-\beta)\alpha) + C\sum_k \left(\prod_{\{1,\ldots,k\}\setminus\{i\}} (A_i r + (1-\beta)\alpha)\right)\right]}{(A_i r + (1-\beta)\alpha)\left[\prod_k (A_i r + (1-\beta)\alpha) + C\sum_k \left(\prod_{\{1,\ldots,k\}\setminus\{i\}} (A_i r + (1-\beta)\alpha)\right)\right]} \frac{-C\sum_k \left[(1-A_i)(w_i + (1-\gamma_i)\eta_i)\prod_{\{1,\ldots,k\}\setminus\{i\}} (A_i r + (1-\beta)\alpha)\right]}{(A_i r + (1-\beta)\alpha)\left[\prod_k (A_i r + (1-\beta)\alpha) + C\sum_k \left(\prod_{\{1,\ldots,k\}\setminus\{i\}} (A_i r + (1-\beta)\alpha)\right)\right]} \quad (3)$$

Let us remember that this means the optimal investment level is positive for up to k agents and from $k+1$ to n, the optimal investment is 0. Breaking down this expression, w_i and the denominator term are positive. Also we are already examining the case where $1 - A_i > 0$. So for those k agents,

$$B_i\left(\prod_k F_i + C\sum_k \left[\prod_{\{1,\ldots,k\}\setminus\{i\}} F_j\right]\right) > C\sum_k \left[B_i \prod_{\{1,\ldots,k\}\setminus\{i\}} F_j\right]$$

is the condition for $LP[\alpha]_i(s^*) \geq 0$ and consequently $s_i^* > 0$.

For $\{k+1, \ldots, n\}$, $B_i\left(\prod_k F_i + C\sum_k \left[\prod_{\{1,\ldots,k\}\setminus\{i\}} F_j\right]\right)$

$\leq C \sum_k \left[B_i \prod_{\{1,...,k\} \setminus \{i\}} F_j \right]$ is the situation.

Carrying forward, the condition for $k+1$ agents would be

$$B_i \left(\prod_{k+1} F_i + C \sum_{k+1} \left[\prod_{\{1,...,k+1\} \setminus \{i\}} F_j \right] \right) > C \sum_{k+1} \left[B_i \prod_{\{1,...,k+1\} \setminus \{i\}} F_j \right].$$

Thus when $k = n$, the unique Nash equilibrium is $s^* = (s_1^*, ..., s_n^*) > 0$ under $(1 - A_i) > 0$ and

$$B_i \left(\prod_N F_i + C \sum_N \left[\prod_{N_{-i}} F_j \right] \right) > C \sum_N \left[B_i \prod_{N_{-i}} F_j \right].$$

The solution is:

$$\begin{gathered} s_i^* = \\ \frac{(1 - A_i)(w_i) \left(\prod_N (A_i r + (1-\beta)\alpha) + C \sum_N \left[\prod_{N_{-i}} (A_i r + (1-\beta)\alpha) \right] \right)}{(A_i r + (1-\beta)\alpha) \left(\prod_N (A_i r + (1-\beta)\alpha) + C \sum_N \left[\prod_{N_{-i}} (A_i r + (1-\beta)\alpha) \right] \right)} \\ - \frac{C \sum_N \left[(1 - A_i)(w_i) \left(\prod_{N_{-i}} (A_i r + (1-\beta)\alpha) \right) \right]}{(A_i r + (1-\beta)\alpha) \left(\prod_N (A_i r + (1-\beta)\alpha) + C \sum_N \left[\prod_{N_{-i}} (A_i r + (1-\beta)\alpha) \right] \right)}. \end{gathered} \tag{4}$$

APPENDIX B

Table B.1: Estimations of OLS with Clustered Robust Standard Errors

Individual Investment is Regressed on Variables Below

	Reg. 1: All Risk Types		Reg. 2: DARA Only	
PRO (300-600)	6.76	(0.83)	10.05	(0.96)
PRO (600-300)	200.0***	(17.05)	208.7***	(13.83)
PRO (600-600)	238.0***	(20.96)	246.1***	(19.51)
EA (300-300)	-18.07**	(-2.41)	-21.70**	(-2.10)
EA (300-600)	6.62	(0.72)	0.71	(0.06)
EA (600-300)	166.4***	(11.28)	164.0***	(9.37)
EA (600-600)	186.5***	(12.97)	192.5***	(11.40)
EL (300-300)	-0.03	(-0.00)	-2.16	(-0.19)
EL (300-600)	3.00	(0.29)	-2.44	(-0.17)
EL (600-300)	211.7***	(13.64)	213.7***	(11.14)
EL (600-600)	225.7***	(15.69)	229.3***	(12.56)
CARA	-29.20*	(-1.85)		
IARA	-7.92	(-0.26)		
Gender	40.18***	(2.71)	42.14**	(2.25)
Quiz	10.07	(0.76)	18.42	(1.06)
Calculator	21.06*	(1.81)	36.28**	(2.25)
Type	0.54	(0.04)	-4.49	(-0.24)
Constant	150.7***	(5.05)	141.2***	(3.55)
Observations		1572		1020

t statistics in parentheses
$^{*}p < 0.10,^{**}p < 0.05,^{***}p < 0.01$

As a comparison of Random Effects Tobit Regressions and OLS with clustered robust standard errors, the results of the OLS estimates will be listed below:

- Both regressions suggest same results as in Random Effect Tobit Models for Hypotheses 1 and 2.
- All 6 tests for coefficients of the OLS estimates support Hypotheses 3 and 4. Furthermore, coefficient tests for Reg. 1 of Table B.1 rejects $H_0 : EA(600 - 300) \geq EA(600 - 600)$ with p-value =0.075.
- No different results were obtained from the coefficient tests compared to the tests don for Hypotheses 5 and 6 in Table 2.15.
- Wald test for coefficients suggest that both PRO (300-300) and EL (300-300) are significantly greater than EA (300-300) in both OLS models. Yet PRO (300-300) and EL (300-300) could not be found significantly different.
- Test results for the rounds with (600-300) endowments remain same with the tests done for Random Effects Tobit Models, there are no significant difference between rules.
- Both for rounds with (600-300) and (600-600) endowments, tests for coefficients have same result obtained from the tests done for Random Effects Tobit Models.

APPENDIX C

Instructions for Session 2 in Turkish:

GENEL BİLGİLER

Bu bir karar alma deneyidir ve bilimsel bir projenin parçasıdır. Bu deneyin amacı, insanların farklı durumlarda nasıl karar verdiğini anlayabilmektir. Kararlarınız “doğru” ya da “yanlış” olarak değerlendirilmeyecektir.

Deneyde elde edeceğiniz kazanç, alacağınız kararlara bağlıdır ve kazancınızın ne şekilde belirleneceği bu yönergede detaylı bir şekilde açıklanmıştır. Bu nedenle, yönergeyi dikkatle okumanız ve anlamanız önemlidir. Elde edeceğiniz kazancın ödemesi, bu deney oturumunun bitiminde seçiminize göre BELİS laboratuvarında veya şahsi banka hesabınıza para transferi olarak yapılacaktır. Kazancınız hakkında diğer katılımcılara bilgi verilmeyecektir. Aldığınız kararlar ve verdiğiniz cevaplar tamamen anonimdir, hiçbir kimlik bilgisi ile eşleştirilmemektedir.

Deney tamamlanana kadar diğer katılımcılarla iletişim kurmanız kesinlikle yasaktır. Deneye başlamadan önce sizinle daha önce paylaşılan link üzerinden Zoom uygulamasına bağlanmış olduğunuzdan emin olun. Deneyin herhangi bir aşamasında bir sorunuz ya da sorununuz olduğunda lütfen Zoom üzerinden yazılı olarak deney yöneticisi ile iletişime geçiniz.

Deney sırasında kopma yaşarsanız, aynı link üzerinden giriş yapıp kaldığınız yerden devam edebilirsiniz. Sorununuzun devam etmesi durumunda lütfen Zoom üzerinden deney yürütücülerinden biriyle iletişime geçin.
Deney sonlanmadan deney uygulamasını ve Zoom oturumunu terketmemeniz gerekmektedir. Tek bir katılımcı dahi deneyi tamamlamazsa, proje ekibi açısından deney

verisi kullanılamaz hale gelecektir.

Deney sonlanmadan deneyi terketmeniz durumunda tarafınıza herhangi bir ödeme yapılmayacak ve bundan sonra yapılacak BELIS deneylerine katılmanız mümkün olmayacaktır.

Deney, 3 aşamadan oluşmaktadır. Her aşama hakkında o aşama başlarken bilgilendirileceksiniz.

BİRİNCİ AŞAMA

- Bu aşama, birbirinden bağımsız 12 karar turundan oluşmaktadır.
- Her turda, deneydeki katılımcılardan biri ile rastgele eşleştirileceksiniz.
- Her tura başlarken size ve eşleştirildiğiniz kişiye 300 ya da 600 puan başlangıç puanı olarak verilecektir. Hem kendinizin hem de eşleştirildiğiniz kişinin başlangıç puanını biliyor olacaksınız. Her turda, siz ve eşleştirildiğiniz kişi eş zamanlı olarak (aynı anda) bireysel başlangıç puanlarınızdan ne kadarını bir projeye yatırmak istediğinize karar vereceksiniz. Başlangıç puanınızın hepsini ya da bir kısmını yatırım için kullanabilir veya tümünü elinizde tutma kararı alabilirsiniz. Tur kazancınız, o tur başlarken size verilen başlangıç puanından projeye yatırmadığınız miktar ve proje yatırımınızın getirisinin toplamına eşit olacaktır.
- Her turda, projeye yatırımınızın sonucu, bilgisayarın 1 ile 100 arasında yapacağı rastgele çekilişe göre belirlenecektir:

  Bilgisayarın çektiği sayı 1 ile 50 arasında (50 dahil) bir sayı olursa (yani %50 ihtimalle) projenin değeri sizin ve eşleştirildiğiniz kişinin projeye yaptığı yatırım toplamının 3 katına çıkacaktır. Bu yeni değer, Orantılılık Kuralı'na göre paylaşılacaktır: Yani, turun başında yaptığınız yatırımların oranına göre siz ve o turda eşleştiğiniz katılımcı arasında paylaştırılacaktır.

*Örnek: Diyelim ki projeye siz 10 puan eşleştirildiğiniz kişi 20 puan yatırım yaptı. Bu durumda, toplam yatırımın 1/3'ü size, 2/3'ü eşleştirildiğiniz kişiye aittir. Bilgisayarın yaptığı çekilişin sonucu olarak projenin değeri artarak (10+20) * 3 = 90 puan olmuşsa, bu 90 puanın 30 puanı (90*(1/3)=30) sizin, 60 puanı (90*(2/3)=60) eşleştirildiğiniz kişinin olacaktır.*

Bilgisayarın çektiği sayı 51 (51 dahil) ve 100 arasında bir sayı olursa (yani %50 ihtimalle) proje toplam yatırım değerinin yarısını kaybedecektir. Yani, projenin geriye kalanının değeri, sizin ve eşleştirildiğiniz kişinin projeye yaptığı toplam yatırımın yarısı olacaktır. Geriye kalan bu değer, tur başında yatırım kararınızı almadan önce size bildirilecek olan şu paylaşım kurallarından birine göre siz ve eşleştirildiğiniz kişi arasında paylaştırılacaktır:

– **Orantılılık:** Projenin geriye kalan değeri siz ve eşleştirildiğiniz kişinin tur başında yaptığı yatırım oranına göre paylaştırılır.

  *Örnek: Diyelim ki projeye siz 200 puan eşleştirildiğiniz kişi 100 puan yatırım yaptı. Yani, toplam yatırımın 2/3'ü size, 1/3'ü eşleştirildiğiniz kişiye ait. Bilgisayarın yaptığı çekilişin sonucu olarak projenin değeri azalarak (100+200)*0,50=150 puan olduğunda, bu 150 puanın 2/3'ü size, 1/3'ü eşleştirildiğiniz kişiye verilecektir. Yani, sizin proje yatırımından kazancınız 150* 2/3 = 100 puan, eşleştirildiğiniz kişininki ise 150*1/3 = 50 puan olacaktır.*

– **Eşit Kayıplar:** Projenin zararı siz ve eşleştirildiğiniz kişi arasında eşit olarak paylaştırılır.

  *Örnek: Diyelim ki, projeye siz 200 puan eşleştirildiğiniz kişi 100 puan yatırım yaptı. Bilgisayarın yaptığı çekilişin sonucu olarak projenin değeri azalarak (100+200)*0,50=150 puan olduğunda, projenin zararı 150 puan olacaktır. Bu zarar, siz ve eşleştirildiğiniz katılımcı arasında eşit olarak paylaştırılacaktır. Yani, hem siz hem de eşleştirilidiğiniz kişi* *proje yatırımından 150*1/2= 75 puan zarar edecek, siz 200-75 = 125, eşleştirildiğiniz kişi 100 – 75= 25 puan elde edecektir.*

– **Eşit Ödüller:** Projenin geriye kalan değeri siz ve eşleştirildiğiniz kişi arasında eşit olarak paylaştırılır.

*Örnek: Diyelim ki projeye siz 200 puan eşleştirildiğiniz kişi 100 puan yatırım yaptı. Diyelim ki çekiliş sonucuna bağlı olarak toplam yatırım azaldı. Projenin değeri azalarak (100+200)*0,50=150 puan olduğunda, bu 150 puan siz ve eşleştirildiğiniz katılımcı arasında eşit olarak paylaştırılacaktır. Yani, hem sizin hem de eşleştirildiğiniz kişinin proje yatırımından elde ettiği 75 puan olacaktır.*

Aşağıdaki tabloda, proje değerinin (%50 ihtimalle) artarak toplam yatırımın 3 katına çıktığı bir durumda ve proje değerinin (%50 ihtimalle) azalarak toplam yatırımın yarısına düştüğü bir durumda paylaşımların nasıl olacağını gösteren bir örnek daha sunulmuştur:

		Proje değeri 3 katına çıktığında	Proje değeri yarı yarıya azaldığında					
		ORANTILILIK	ORANTILILIK		EŞİT ÖDÜLLER		EŞİT KAYIPLAR	
	YATIRIM	GETİRİ	GETİRİ	ZARAR	GETİRİ	ZARAR	GETİRİ	ZARAR
Kişi 1	150	450	75	75	50	100	100	50
Kişi 2	50	150	25	25	50	0	0	50
TOPLAM	200	600	100	100	100	100	100	100

Deney sonuna kadar bu aşamada yer alan 12 turda aldığınız yatırım kararlarının sonuçlarını ve dolayısı ile tur kazançlarınızı göremeyeceksiniz. Yani, her tura başlarken, bir önceki turda eşleştirildiğiniz kişinin yaptığı yatırım miktarını, yatırımın sonucunu ve tur kazancınızı bilmiyor olacaksınız.

BLOKLAR

- Bu aşamada yer alan 12 karar turu, her biri 4 tur içeren 3 blok olarak gerçekleşecektir.
- Her blokta yer alan tüm turlarda (yani 12 turun hepsinde) bilgisayarın sayı çekilişi sonucu proje değeri artarsa bu değer Orantılılık Kuralı'na göre siz ve eşleştirildiğiniz kişi arasında paylaştırılacaktır.
- Bilgisayarın sayı çekilişi sonucu proje değeri azalırsa uygulanacak paylaşım kuralı, bir blok içinde yer alan 4 tur boyunca aynı kalacak, ama her blok için farklı bir kural geçerli olacaktır. (Örneğin, 4 turluk birinci blokta Orantılılık, 4 turluk ikinci blokta Eşit Kayıplar, 4 turluk üçüncü blokta Eşit Ödüller kuralı uygulanacaktır.)
- Her blok başlamadan önce, blokta yer alan 4 tur için geçerli olacak ve proje değerinin azalması ile sonuçlanan durumlarda uygulanacak paylaşım kuralı duyurulacak, kural açıklanacak ve kuralı doğru olarak anladığınızı test edebilmeniz için size birkaç soru sorulacaktır.
- Her bloğun ilk turunda hem sizin hem de karşınızdaki kişinin 300'er puanı, ikinci ve üçüncü turlarda birinizin 300 diğerinizin 600 puanı ve son turda her ikinizin de 600'er puanı olacaktır.
- Her bloğun her turunda, yatırım kararınızı alırken kullanabileceğiniz bir hesap makinesi ekranınızda olacaktır. Yatırım kararınızı almadan önce, bu hesap makinesini kullanarak, ilgili kutucuklarında sizin ve eşleştirildiğiniz kişinin yapabileceği farklı yatırım miktarlarını deneyerek, projenin sonucuna ve geçerli paylaşım kuralına göre kazancınızın ne olacağını hesap edebilirsiniz.

BİRİNCİ AŞAMA KAZANCINIZ NASIL HESAPLANACAK?

Deney sonunda, bu aşamadaki 12 turun her birinde elde ettiğiniz tur kazançları ekranınıza gelecektir. Sonrasında, her blokta yer alan 4 turdan biri rastgele seçilecektir. Seçilen bu 3 turda (3 blok x 1 tur) elde ettiğiniz puanların toplamı Birinci Aşama kazancınızı oluşturacaktır. Birinci Aşama'da kazandığınız her puan 0,01 TL ile çarpılacak, deney sonunda tarafınıza ödenecektir.

İKİNCİ AŞAMA

- Deneyin bu aşamasında, Birinci Aşama'da gerçekleşmiş olan 3 turda eşleşmiş olduğunuz kişilerin aldıkları yatırım kararlarını tahmin etmeniz istenmektedir.
- Bilgisayarın sayı çekilişi sonucunda proje değerinin azalması durumunda uygulanacak paylaşım kurallarının (Orantılılık, Eşit Kayıplar, Eşit Ödüller) her biri için aşağıdaki soru ve yanıt şıkları ekranınıza gelecektir:

> Deneyin Birinci Aşama'sında, proje değerinin yarı yarıya azalması durumunda ………………...... paylaşım kuralı geçerliyken, bir başkasıyla eşleştiğinde (300,300) başlangıç puanlarının olduğu durumda X kadar yatırım yapmış bir katılımcı, sizinle eşleştiğinde sizin başlangıç puanınız 300, onunki 600 olduğu durumda sizce ne kadar yatırım yapmıştır?
>
> – X kadar
>
> – X'ten fazla
>
> – X'ten az

- Bu aşamada yer alacak 3 tahmin sorusuna verdiğiniz yanıtların doğruluğuna dair size deney sonunda bilgilendirme yapılacaktır.

İKİNCİ AŞAMA KAZANCINIZ NASIL HESAPLANACAK?

Bu aşamadaki 3 tahmin sorusundan biri bilgisayar tarafından rastgele seçilecektir. Seçilen soruya verdiğiniz yanıt doğru ise, İkinci Aşama kazancınız 200 puan olacak ve her puan 0,01 TL ile çarpılarak, deney sonunda tarafınıza ödenecektir.

ÜÇÜNCÜ AŞAMA

- Bu aşama, birbirinden bağımsız 3 bölümden oluşmaktadır.

- Her bölümde yer alan 10 tur süresince iki farklı yatırım aracı ile ilgili yatırım kararları almanız istenecektir. Alacağınız yatırım kararı tamamen bireysel olacaktır. Yani, kazancınız sadece kendi yatırım kararlarınızın sonucu olarak oluşacaktır.

- Elinizdeki sermayeyi iki farklı yatırım aracı olan A ve B arasında paylaştırmanız istenecektir: Her turda size A aracına yatırmak istediğiniz puan sorulacak, A'ya yatırmadığınız sermaye otomatik olarak B'ye yatırımınız olarak kaydedilecektir.

- Her bölüm başlarken size 500 puan sermaye olarak verilecektir. 1. turda size sermaye olarak verilen 500 puanın ne kadarını A'ya ne kadarını B'ye yatıracağınıza karar vereceksiniz. 1. turdaki yatırımlarınızdan elde edeceğiniz getiri 2. turdaki sermayeniz, 2. turdaki yatırımlarınızdan elde ettiğiniz getiri 3. turdaki sermayeniz olacaktır. 10 tur boyunca bu şekilde ilerlenecektir. Her bölümde kaçıncı turda olduğunuz, o tura ne kadar sermaye ile başladığınız size hatırlatılacaktır. 10. turdaki yatırımlarınızdan elde ettiğiniz puan ise o bölümün kazancı olacaktır ve bölüm sonlanacaktır. Bir sonraki bölüme yine 500 puan sermaye ile başlayacaksınız.

- A ve B yatırım araçlarının getirileri şu şekildedir:

  – A aracının getiri oranı bilgisayar tarafından bazı aralıklarda belirlenecek, her oran aralığının seçilme olasılığı ise aynı olmayacaktır: A aracına yatıracağınız puanlar %20 ihtimalle 0 ve 0.67 arasında bir çarpanla, %30 ihtimalle 0.67 ve 1.06 arasında bir çarpanla, %30 ihtimalle 1.06 ve 1.7 arasında bir çarpanla, %20 ihtimalle de 1.7'den yüksek bir çarpanla çarpılacaktır. Aşağıdaki tabloda bu bilgiler özetlenmiştir:

A’nın Getiri Çarpanı	Olasılık
0 - 0.67	%20
0.67 - 1.06	%30
1.06 - 1.7	%30
1.7’den fazla	%20

Yukarıdaki tabloda gösterilen aralıklardan her biri için, A’nın getirisi bilgisayar tarafından söz konusu aralıktan rastgele çekilecektir. Yani, örneğin, 1.06-1.7 aralığı çekilmişse bilgisayar 1.06 ile 1.7 arasında bir çarpanı rastgele olarak A’nın getiri oranı olarak atayacaktır.

Her turda, A aracının getiri oran aralığı ve o aralıktan rastgele çekilecek oran tekrar belirlenecektir. Yani, örneğin, A’nın getiri oranı 1. turda 1.06 -1.7 aralığından 1.2 olarak, 2. Turda ise 0-0.67 aralığından 0.3 olarak seçilebilir.

– B aracının getiri oranı ise sabittir: B’ye yatırılan puanlar her zaman 1.03 ile çarpılacaktır. Bu oran, her turda aynıdır.

Örnek: Diyelim ki, 1. turda 500 puan sermayenizin 300'ünü A'ya yatırdınız. Yani, 200 puanınızı da B'ye yatırmış oldunuz. A'nın getiri çarpanı 0.72 olarak belirlenirse, A'ya yaptığınız yatırımdan 300*0.72= 216 puan getiriniz olacak. B'ye yatırımınızdan ise 200*1.03 = 206 puan elde edeceksiniz. Bu durumda, 1. turda elde ettiğiniz 216 + 206 = 422 puan 2. tur sermayenizi oluşturacaktır. 2. turda 422 puandan ne kadarını A'ya (ve dolayısı ile B'ye) yatıracağınıza karar vereceksiniz. B'nin getirisi aynı kalacak ama A'nın getiri çarpanı yukarıda belirtildiği şekilde bilgisayar tarafından tekrar atanacaktır.

Örnek: Diyelim ki, 1. turda 500 puan sermayenizin 150'sini A'ya yatırdınız. Yani, 350 puanınızı da B'ye yatırmış oldunuz. A'nın getiri çarpanı 1.85 olarak belirlenirse, A'ya yaptığınız yatırımdan 150*1.85= 277.5 puan getiriniz olacak. B'ye yatırımınızdan ise 350*1.03 = 360.5 puan elde edeceksiniz. Bu durumda, 1. turda elde ettiğiniz 277.5 + 360.5 = 638 puan 2. tur sermayenizi oluşturacaktır. 2. turda 638 puandan ne kadarını A'ya (ve dolayısı ile B'ye) yatıracağınıza karar vereceksiniz. B'nin getirisi aynı kalacak ama A'nın getiri çarpanı yukarıda belirtildiği şekilde bilgisayar tarafından tekrar atanacaktır.

ÜÇÜNCÜ AŞAMA KAZANCINIZ NASIL HESAPLANACAK?

Bu aşamada yer alan 3 bölümden bir tanesi rastgele seçilecek ve o bölümde elde ettiğiniz puanlar (yani o bölümün 10.turunda yaptığınız yatırımın sonucunda elde ettikleriniz) 0.01 TL ile çarpılarak tarafınıza ödenecektir.

Instructions for Session 2 in English:

GENERAL INSTRUCTIONS

This is a decision-making experiment, and it is part of a scientific project. The purpose of the experiment is to understand how humans make decisions under different circumstances. Your decisions will not be evaluated as ”true” or ”wrong”.

The revenue you will receive from the experiment is up to your choices and the way your revenue is determined will be explained in details in this instructions. Therefore, it is important that you read and understand the instruction carefully.The payment of your earnings will be made at the end of this experiment session, depending on your choice, at the BELIS laboratory or as a money transfer to your personal bank account. Other participants will not be informed about your earnings. The decisions you make and the answers you give are completely anonymous, they are not matched with any identity information.

Communicating with other participants is strictly forbidden until the experiment is complete. Before starting the experiment, make sure that you are connected to the Zoom application via the link shared with you. If you have a question or a problem at any stage of the experiment, please contact the experiment manager via Zoom.

If you experience a disconnection during the experiment, you can log in via the same link and continue where you left off. If your problem persists, please contact one of the experimenters via Zoom.

You must not leave the experiment application and Zoom session before the end of the experiment. If even a single participant does not complete the experiment, the experiment data will become unusable for the project team.

If you leave the experiment before the end of the experiment, you will not receive any payment and you will not be able to participate in the BELIS experiments to be held in the future.

The experiment consists of 3 stages. You will be informed about each stage as that stage begins.

STAGE 1

- This stage consists of 12 independent rounds.
- In each round, you will be randomly matched with one of the participants in the experiment.
- At the start of each round, you and the person you are matched with will be given 300 or 600 points as endowments. You will be informed of the endowments of both yourself and the person you are matched with. In each round, you and the subject you are matched will simultaneously decide how much of your endowments you want to invest in a project. You can use all or a part of your points for investment, or you can decide to keep all of it. Your earnings from each round will be equal to the sum of the amount you did not invest in the project and the return on your project investment.
- Each round, the outcome of your investment in the project will be determined by a random number generation of the computer between 1 and 100:

  If the number drawn by the computer is between 1 and 50 (including 50) (that is, there is a 50% probability) the value of the project will be 3 times the sum of the investment made by you and the person you are matched with. This new value will be shared according to the Proportionality: that is, it will be shared between you and the participant you were matched in that round, based on the proportion of your investments at the beginning of the round.

*Example: Let's say you invested 10 points, the person you were matched with invested 20 points. In this case, 1/3 of the total investment belongs to you and 2/3 to the person you are matched with. If the value of the project has increased to (10+20) * 3 = 90 points as a result of random number generated by computer, 30 points (90*(1/3)=30) of these 90 points are yours, 60 points (90*(2/3)=60) will be the person's you are paired with.*

If the number drawn by the computer is between 51 (including 51) and 100 (ie, there is a 50% probability) the project will lose half of the total investment value. The value of the remainder of the project will be half of the total investment you and the person you were matched with made in the project. This remaining value will be shared between you and the person mathched with you according to one of the following division rules, which will be informed to you at the beginning of the round before you make investment:

- **Proportionality:** The remaining value of the project is shared according to the investment ratio of you and the person you were matched with at the beginning of the tour.

  *Example: Let's say you invested 200 points in the project, the person you were matched with invested 100 points. That is, 2/3 of the total investment belongs to you and 1/3 belongs to the person you are matched with. When the value of the project decreases to (100+200)*0.50=150 points as a result of the draw made by the computer , 2/3 of these 150 points will be given to you and 1/3 to the person you are matched with. Your profit from the project will be 150* 2/3 = 100 points, and that of the person you are matched with will be 150 * 1/3 = 50 points.*

- **Equal Losses:** The loss of the project is shared equally between you and the person you are matched with..

  Example: Let's say you invested 200 points in the project, the person you were matched with invested 100 points. When the value of the project *decreases to (100+200)*0.50=150 points as a result of the draw made by the computer , the loss of the project will be 150 points. This loss will be split equally between you and the participant you are matched with. That is, both you and the person you are matched with will lose 150*1/2= 75 points from the project, you will gain 200-75 = 125, and the person you are matched with will get 100 – 75= 25 points.*

– **Equal Awards:** The remaining value of the project is shared equally between you and the person you are matched with.

  *Example: Let's say you invested 200 points in the project, the person you were matched with invested 100 points. Let's say the total investment decreased depending on the result of the number draw. When the value of the project decreases to (100+200)*0.50=150 points, these 150 points will be shared equally between you and the participant you are matched with. That is, both you and the person you are matched with will get 75 points from the project.*

In the table below, another example is presented that shows how the shares will be in a situation where the project value increases (with 50% probability) and triples the total investment, and in a situation where the project value decreases (with 50% probability) and decreases to half of the total investment:

		When Project Value Triples	When Project Value Reduces to its 50%					
		PRO	PRO		EA		EL	
	INVESTMENT	RETURN	RETURN	LOSS	RETURN	LOSS	RETURN	LOSS
Investor 1	150	450	75	75	50	100	100	50
Investor 2	50	150	25	25	50	0	0	50
TOTAL	200	600	100	100	100	100	100	100

Until the end of the experiment, you will not be able to see the results of the investment decisions you made and your earnings in the 12 rounds at this stage. When a new round starts, you will not know the amount invested by the person you were matched with in the previous round, the result of the investment and your earnings from the round.

BLOCKS

- The 12 decision rounds in this stage will take place in 3 blocks, each of which consists of 4 rounds.
- If the project value increases as a result of the number draw, in all rounds in each block, the total value will be shared between you and the person you are matched with according to Proportionality.
- If the project value decreases as a result of the computer's number draw, the sharing rule to be applied will remain the same for 4 rounds in a block, but a different rule will be valid for each block. (For example, Proportionality will apply in the first block of 4 turns, Equal Losses in the second block of 4 turns, and Equal Awards in the third block of 4 turns.)
- Before each block starts, the division rule that will be valid for the 4 rounds in the block and which will be applied in cases that result in a decrease in the project value will be announced, the rule will be explained, and you will be asked a few questions so that you can test your understanding of the rule correctly.
- In the first round of each block, both you and the other person will have 300 points, in the second and third rounds one of you will have 300 points, the other will have 600 points, and in the last round, you will both have 600 points.
- You will have a calculator on your screen in each round of each block that

you can use while making your investment decision. Before making your investment decision, you can use this calculator to try out different amounts that would be invested by you and the person you are matched with in the relevant boxes, and calculate what your earnings will be according to the outcome of the project and the current sharing rule.

HOW WILL YOUR EARNINGS FROM STAGE 1 BE CALCULATED?

At the end of the experiment, your earnings will appear on your screen for each of the 12 rounds in this stage. Afterwards, one of the 4 rounds in each block will be chosen randomly. The sum of points you get in these 3 selected rounds (3 blocks x 1 round) will form your Stage 1 earnings. Each point you earn in Stage 1 will be multiplied by 0.01 TL and will be paid to you at the end of the experiment.

STAGE 2

- In this phase of the experiment, you will be asked to predict the investment decisions of the people you were matched with in the 3 rounds that took place in Stage 1.
- The following question and answer options will appear on your screen for each of the division rules (Proportionality, Equal Losses, Equal Awards) to be applied in case the project value decreases as a result of the computer's number drawing:

In Stage 1, under ... bankruptcy rule, suppose an investor invested ”X” points when endowments were (300,300). What will be the other investor’s investment in case your endowment remains at 300 and her endowment is 600?

- Exactly ”X”
- More than ”X”
- Less than ”X”

- At the end of the experiment, you will be informed about the accuracy of your answers to the 3 guessing questions that will take place at this stage.

HOW WILL YOUR EARNINGS FROM STAGE 2 BE CALCULATED?

One of the 3 guessing questions at this stage will be randomly selected by the computer. If your answer to the selected question is correct, your Stage 2 earnings will be 200 points and each point will be multiplied by 0.01 TL and paid to you at the end of the experiment.

STAGE 3

- This stage consists of 3 independent sections.
- During the 10 rounds in each section, you will be asked to make investment decisions regarding two different investment instruments. The investment decision you make will be completely individual. That is, your earnings will only occur as a result of your own investment decisions.
- You will be asked to divide your capital between two different investment instruments, A and B: In each round, you will be asked for the points you

want to invest in instrument A, and the capital you do not invest in A will automatically be recorded as your investment in B.

- At the beginning of each section, you will receive 500 points as capital. In the 1st round, you will decide how much of the 500 points given to you as capital will be invested in A and how much in B. The return from your investments in the 1st round will be your capital in the 2nd round, and the return from your investments in the 2nd round will be your capital in the 3rd round. It will proceed in this way for 10 rounds. In each section, you will be reminded of which round you are in and how much capital you have. The points you earn from your investments in the 10th round will be the revenue of that section and the section will end. You will start the next chapter with 500 points capital again.

- The returns of instruments A and B are as follows:

  – The rate of return of tool A will be determined by the computer in some ranges, while the probability of choosing a rate from an interval will not be the same: The points you deposit on tool A will be multiplied by a factor between 0 and 0.67 with a 20% probability, a multiplier between 0.67 and 1.06 at a 30% probability, a multiplier between 1.06 and 1.7 at a 30% probability, and a multiplier higher than 1.7 at a 20% probability. The table below summarizes this information:

A’ Rate of Return	Probability
0 - 0.67	%20
0.67 - 1.06	%30
1.06 - 1.7	%30
More than 1.7	%20

For each of the intervals shown in the table above, the payoff multiplier for A will be randomly drawn from that interval by the computer. So, for example, if the interval 1.06-1.7 is drawn, the computer will randomly assign a multiplier between 1.06 and 1.7 as the rate of return for A.

In each round, the rate range of vehicle A and the rate to be drawn randomly from that range will be determined again. So, for example, A's rate of return can be chosen as 1.2 from the range 1.06 -1.7 in Round 1, and 0.3 from the range 0-0.67 in Round 2.

– The rate of return on instrument B is fixed: points invested in B will always be multiplied by 1.03. This rate remains same in each round.

Example: Let's say you invested 300 of your 500 point in A in round 1. So, you have invested your 200 points on B. If A's rate of return is set to 0.72, you will receive 300*0.72= 216 points from your investment in A. You will receive 200*1.03 = 206 points from your investment in B. n this case, 216 + 206 = 422 points earned in round 1 will form your 2nd round capital. In round 2, you will decide on how much of the 422 points you want to invest in A (and therefore in B). B's rate of return will remain the same, but A's rate of return will be randomly drawn by the computer as described above.
Example: Let's say you invested 150 of your 500 points in A in the 1st round. So, you have invested your 350 points on B. If A's rate of return is set to 1.85, you will have a return of 150 * 1.85 = 277.5 points on your investment in A. You will have 350*1.03 = 360.5 points from your investment in B. In this case, 277.5 + 360.5 = 638 points obtained in round 1 will form your 2nd round capital. In round 2, you decide how much of the 638 points you want to bet on A (and therefore on B). B's rate of return will remain the same, but A's rate of return will be randomly drawn by the computer as described above.

HOW WILL YOUR EARNINGS FROM STAGE 3 BE CALCULATED?

At this stage, one of the 3 sections will be chosen randomly and the points you earn in that section (i.e., what you earn as a result of your investment in the 10th round of that section) will be multiplied by 0.01 TL and paid to you.

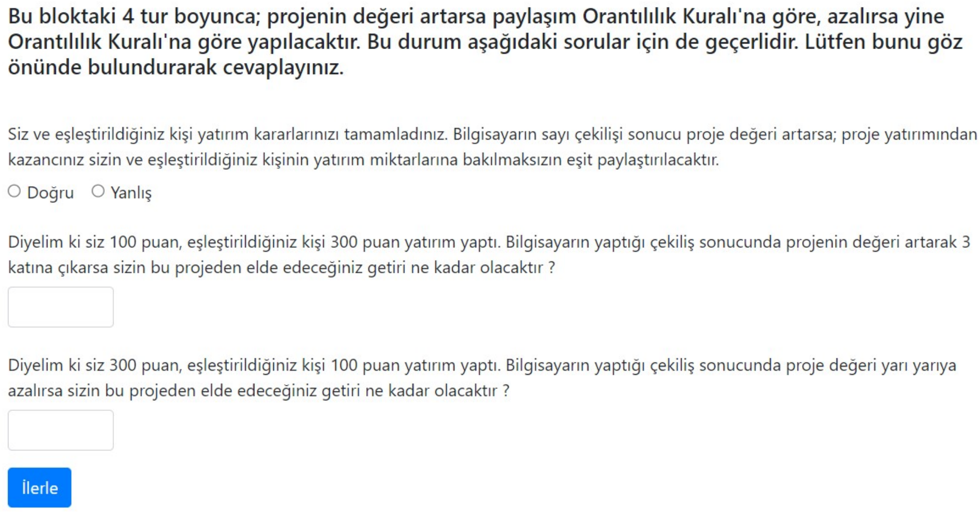
APPENDIX D

Screenshots of webpages of experiment:

Figure D.1: Welcome Screen

Figure D.2: General Instructions

Figure D.3: Quiz for Proportionality



Bu bloktaki 4 tur boyunca; projenin değeri artarsa paylaşım Orantılılık Kuralı'na göre, azalırsa yine Orantılılık Kuralı'na göre yapılacaktır. Bu durum aşağıdaki sorular için de geçerlidir. Lütfen bunu göz önünde bulundurarak cevaplayınız.

Siz ve eşleştirildiğiniz kişi yatırım kararlarınızı tamamladınız. Bilgisayarın sayı çekilişi sonucu proje değeri artarsa; proje yatırımından kazancınız sizin ve eşleştirildiğiniz kişinin yatırım miktarlarına bakılmaksızın eşit paylaştırılacaktır.

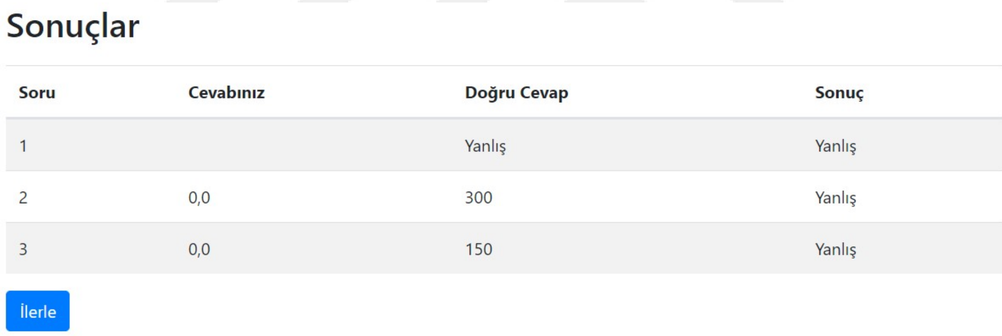
○ Doğru ○ Yanlış

Diyelim ki siz 100 puan, eşleştirildiğiniz kişi 300 puan yatırım yaptı. Bilgisayarın yaptığı çekiliş sonucunda projenin değeri artarak 3 katına çıkarsa sizin bu projeden elde edeceğiniz getiri ne kadar olacaktır ?

Diyelim ki siz 300 puan, eşleştirildiğiniz kişi 100 puan yatırım yaptı. Bilgisayarın yaptığı çekiliş sonucunda proje değeri yarı yarıya azalırsa sizin bu projeden elde edeceğiniz getiri ne kadar olacaktır ?

İlerle

Figure D.4: Quiz Results



Sonuçlar

Soru	Cevabınız	Doğru Cevap	Sonuç
1		Yanlış	Yanlış
2	0,0	300	Yanlış
3	0,0	150	Yanlış

İlerle

Figure D.5: Investment Page

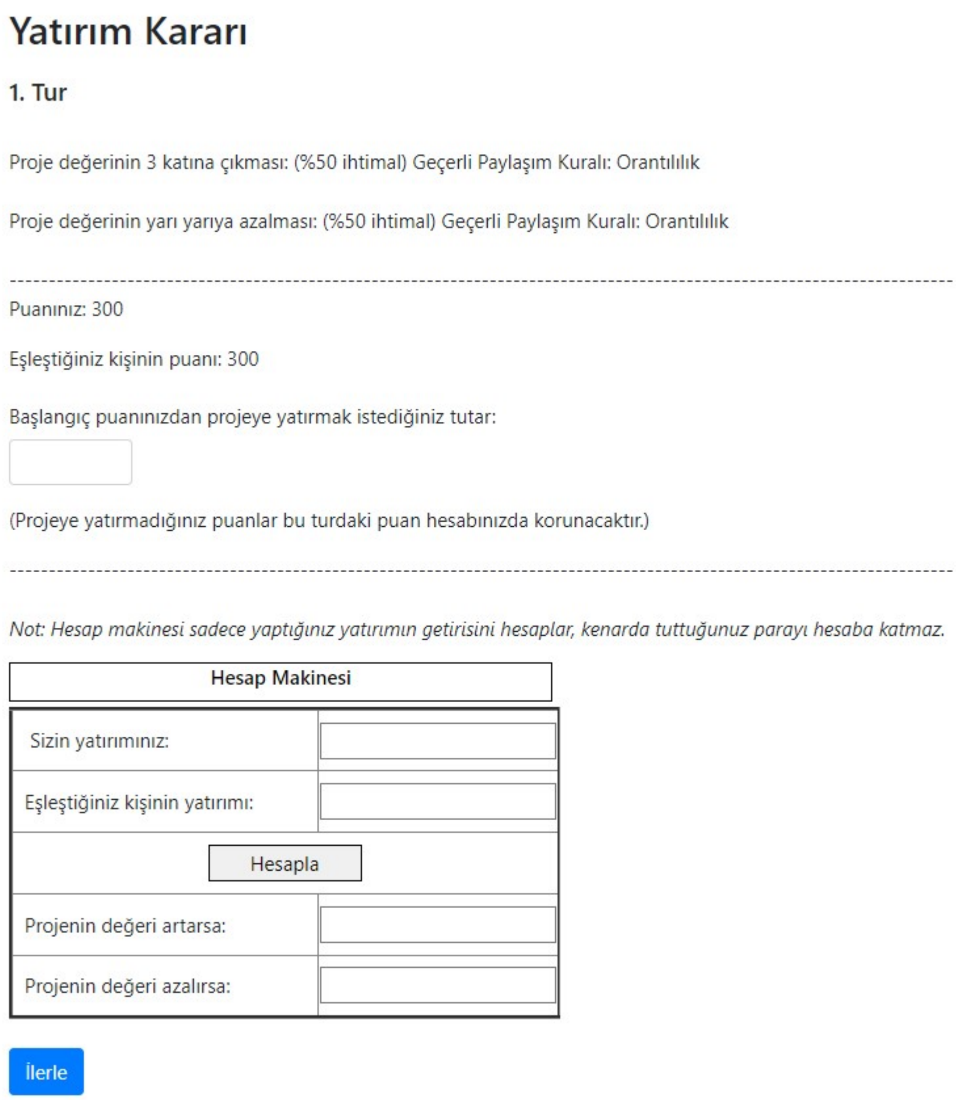


Figure D.6: Investment Page

Figure D.7: Belief Elicitation Question

Tahminler

Deneyin Birinci Aşama'sında, proje değerinin yarı yarıya azalması durumunda Orantılılık paylaşım kuralı geçerliyken, bir başkasıyla eşleştiğinde (300,300) başlangıç puanlarının olduğu durumda "X" kadar yatırım yapmış bir katılımcı, sizinle eşleştiğinde sizin başlangıç puanınız 300, onunki 600 olduğu durumda sizce ne kadar yatırım yapmıştır?

○ "X"ten fazla ○ "X" kadar ○ "X"ten az

İlerle

Figure D.8: Stage 3 - Investment Screen

Portfolyo Kararı

1. Bölüm - 1. Tur

A'ya yatırmadığınız puanlar otomatik olarak B'de **1.03 sabit çarpan** ile değerlendirilecektir.

- A'nın getiri çarpanının bağlı olduğu olasılıklar:

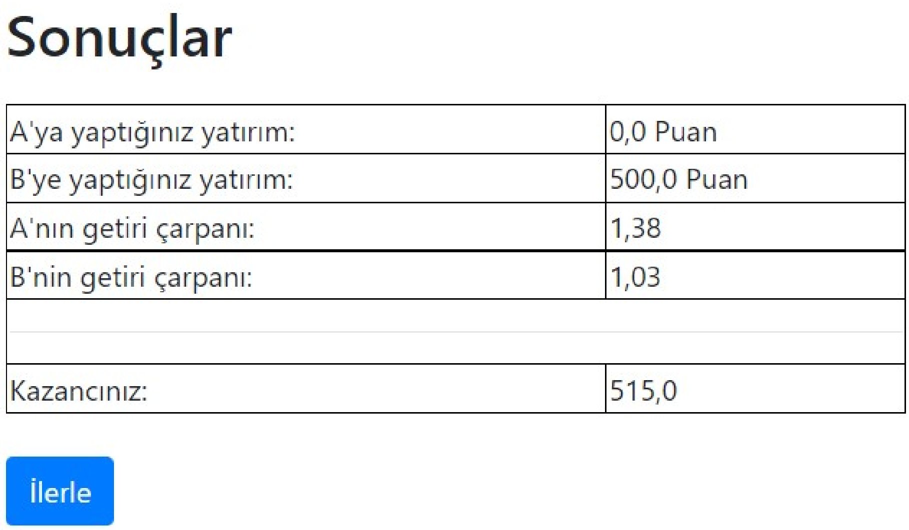
A'nın getiri çarpanı	Olasılık
0 - 0.67	%20
0.67 - 1.06	%30
1.06 - 1.7	%30
1.7'den fazla	%20

0 ile **500** puan arasında kaç puanınızı A'ya yatırmak istersiniz ?

A aracına yatırımınız:

İlerle

Figure D.9: Stage 3 - Investment Results



Sonuçlar

A'ya yaptığınız yatırım:	0,0 Puan
B'ye yaptığınız yatırım:	500,0 Puan
A'nın getiri çarpanı:	1,38
B'nin getiri çarpanı:	1,03
Kazancınız:	515,0

İlerle

Figure D.10: First Survey Question

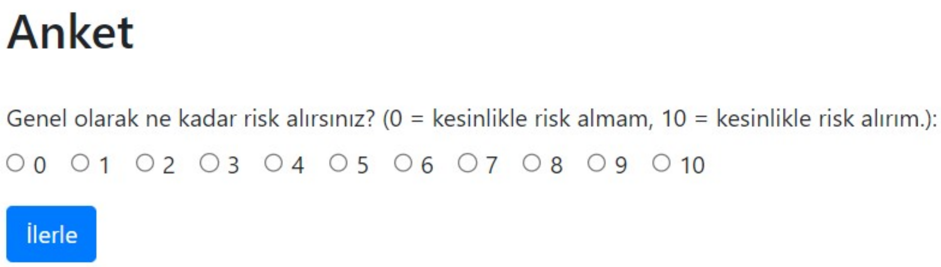


Figure D.11: Bonus Payment

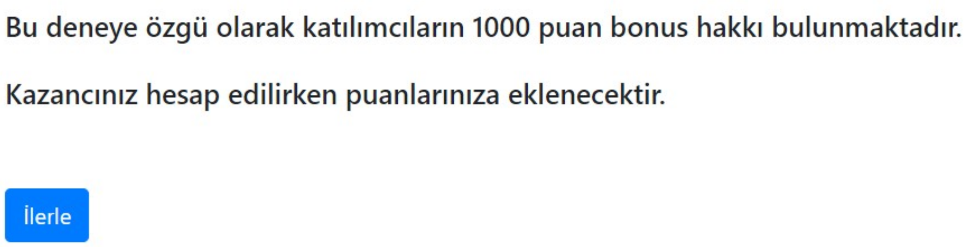


Figure D.12: Results of Stage 1

1. aşamanın sonuçları:

Blok	Tur	Projeye Yatırımınız	Projenin Toplam Yatırımı	Proje Değeri	Projenin Toplam Getirisi	Sizin Kazancınız
1	1	0	0	Azaldı	0,0	300,0
1	2	0	0	Arttı	0	600,0
1	3	0	0	Azaldı	0,0	300,0
1	4	0	0	Azaldı	0,0	600,0

Blok	Tur	Projeye Yatırımınız	Projenin Toplam Yatırımı	Proje Değeri	Projenin Toplam Getirisi	Sizin Kazancınız
2	1	0	0	Azaldı	0,0	300,0
2	2	0	0	Arttı	0	600,0
2	3	0	0	Azaldı	0,0	300,0
2	4	0	0	Azaldı	0,0	600,0

Blok	Tur	Projeye Yatırımınız	Projenin Toplam Yatırımı	Proje Değeri	Projenin Toplam Getirisi	Sizin Kazancınız
3	1	0	0	Azaldı	0,0	300,0
3	2	0	0	Arttı	0	600,0
3	3	0	0	Arttı	0	300,0
3	4	0	0	Arttı	0	600,0

1. aşamada ödeme için rastgele seçilen turlar ve kazançlarınız:

1. bloktan 4. tur ve 600,0 Puan,

2. bloktan 2. tur ve 600,0 Puan,

3. bloktan 4. tur ve 600,0 Puan.

Figure D.13: Results of Stages 2 and 3

2. aşamanın sonuçları

Soru	Kural	Yanıtınız	Doğru Cevap	Sonuç
1	Orantılılık		"X" kadar	Yanlış
2	Eşit Kayıplar		"X" kadar	Yanlış
3	Eşit Ödüller		"X" kadar	Yanlış

2. aşamada ödeme için 1. soru seçilmiştir. Kazancınız: 0 Puan.

3. aşamanın sonuçları:

Blok	10. Turdaki Kazanç
1	671,95
2	671,95
3	671,95

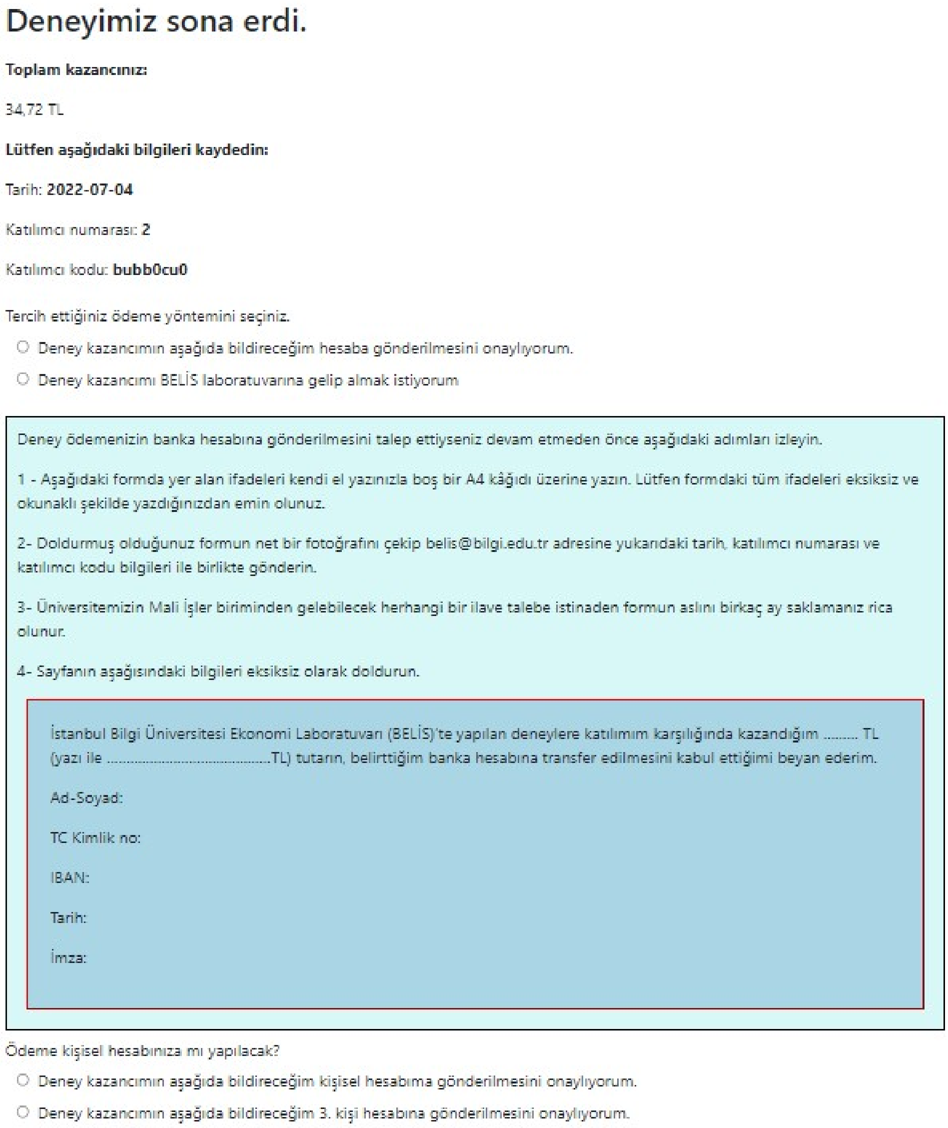
3 bölüm içinden 3. bölüm ödeme için rastgele belirlenmiştir. Bu aşamadan kazancınız: 671,95 Puan

1000 Puan bonusunuz hesabınıza eklenmiştir.

Lütfen ödeme bilgileri için sonraki sayfaya ilerleyin.

İlerle

Figure D.14: Payment Page



Deneyimiz sona erdi.

Toplam kazancınız:

34,72 TL

Lütfen aşağıdaki bilgileri kaydedin:

Tarih: **2022-07-04**

Katılımcı numarası: **2**

Katılımcı kodu: **bubb0cu0**

Tercih ettiğiniz ödeme yöntemini seçiniz.

- ○ Deney kazancımın aşağıda bildireceğim hesaba gönderilmesini onaylıyorum.
- ○ Deney kazancımı BELİS laboratuvarına gelip almak istiyorum

Deney ödemenizin banka hesabına gönderilmesini talep ettiyseniz devam etmeden önce aşağıdaki adımları izleyin.

1 - Aşağıdaki formda yer alan ifadeleri kendi el yazınızla boş bir A4 kâğıdı üzerine yazın. Lütfen formdaki tüm ifadeleri eksiksiz ve okunaklı şekilde yazdığınızdan emin olunuz.

2- Doldurmuş olduğunuz formun net bir fotoğrafını çekip belis@bilgi.edu.tr adresine yukarıdaki tarih, katılımcı numarası ve katılımcı kodu bilgileri ile birlikte gönderin.

3- Üniversitemizin Mali İşler biriminden gelebilecek herhangi bir ilave talebe istinaden formun aslını birkaç ay saklamanız rica olunur.

4- Sayfanın aşağısındaki bilgileri eksiksiz olarak doldurun.

İstanbul Bilgi Üniversitesi Ekonomi Laboratuvarı (BELİS)'te yapılan deneylere katılımım karşılığında kazandığım .... TL (yazı ile ....TL) tutarın, belirttiğim banka hesabına transfer edilmesini kabul ettiğimi beyan ederim.

Ad-Soyad:

TC Kimlik no:

IBAN:

Tarih:

İmza:

Ödeme kişisel hesabınıza mı yapılacak?

- ○ Deney kazancımın aşağıda bildireceğim kişisel hesabıma gönderilmesini onaylıyorum.
- ○ Deney kazancımın aşağıda bildireceğim 3. kişi hesabına gönderilmesini onaylıyorum.

ETHICS BOARD APPROVAL

Ethics Board Approval is available in the printed version of this dissertation.