MEASURES OF INDIVIDUAL RISK ATTITUDES AND PORTFOLIO CHOICE: EVIDENCE FROM AN INVESTMENT COMPETITION

HANİFE ARMUT

BOĞAZİÇİ UNIVERSITY

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MEASURES OF INDIVIDUAL RISK ATTITUDES AND PORTFOLIO CHOICE: EVIDENCE FROM AN INVESTMENT COMPETITION

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Hanife Armut

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DECLARATION OF ORIGINALITY

I, Hanife Armut, certify that

- I am the sole author of this thesis and that I have fully acknowledged and documented in my thesis all sources of ideas and words, including digital resources, which have been produced or published by another person or institution;
- this thesis contains no material that has been submitted or accepted for a degree or diploma in any other educational institution;
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Date 18.07.2018

ABSTRACT

Measures of Individual Risk Attitudes and Portfolio Choice:

Evidence From an Investment Competition

In this paper, I employ a large incentivized student sample who are also participants of an investment competition to investigate how different risk-attitude measurements have a relation with each other, with demographic features and to risk preferences and perceptions in the competition. The measures are self-reported willingness to take risks in general, willingness of the person to take risks in financial decisions, prudence level, ambiguity aversion and loss aversion. Firstly, it is discovered that the sample features lower risk-aversion, higher loss-aversion, higher ambiguity-aversion and higher prudence. Next, simple correlation indicates that the strongest relation between distinct measures is discovered between the self-reported willingness to take risks and loss aversion. Finally, after dividing investment transaction to two different groups, participants having more diversified portfolio exhibits more risk aversion. In addition to that, there exits a positive correlation between taking higher leverage in future contracts and being more risk lover.

ÖZET

Bireysel Risk Tutumu Ölçümleri ve Portföy Seçimi:

Bir Yatırım Yarışmasından Elde Edilen Kanıtlar

Bu yazıda, farklı risk-tutum ölçümlerinin birbiriyle, demografik özelliklerle ve bir yatırım yarışmasındaki risk alma davranışlarıyla nasıl ilişkilendirildiğini araştırmak için yatırım yarışmasının katılımcılarını da içeren büyük teşvikli bir öğrenci örneği kullandım. Bu ölçütler, bildirilen genel olarak risk bildirme isteği, kişinin finansal kararlarda risk alma isteği, ihtiyatlılık düzeyi, belirsizlikten kaçınma ve kayıptan kaçınma istekliliğidir. Öncelikle, örneklemin daha düşük riskten kaçınma, daha yüksek kayıptan kaçınma, daha yüksek belirsizlikten kaçınma ve daha ihtiyatlı olduğu görülmektedir. Daha sonra, basit korelasyon, bildirilen genel olarak risk bildirme isteği ile kayıptan kaçınma arasında en güçlü ilişkinin gözlemlendiğini göstermektedir. Son olarak, yatırım işlemini iki farklı gruba böldükten sonra, daha çeşitli portföylere sahip olan katılımcılar daha fazla riskten kaçınma sergilemektedir. Buna ek olarak, vadeli işlem sözleşmelerinde daha yüksek kaldıraç alma ve daha risk sever olma arasında pozitif bir ilişki vardır.

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CHAPTER 1

INTRODUCTION

A large amount of research in modern economics has assumed that people are rational economic agents. However, ample body of empirical research provides an evidence that real investors are affected by their external environment, by the media. The following lists the most commonly known biases that are observed in the investment behavior (Baker & Ricciardi, 2014): overconfidence, regret, financial cognitive dissonance, prospect theory, disposition effect, familiarity bias (Ricciardi & Simon, 2000).

In this study, through employing a large student sample, I have tested how different risk-attitude measurements have a relation with each other, with demographic features and to risk preferences and perceptions in the competition. In order to do this, an online platform for experiment and survey is constructed and participants, who make portfolio choices in an investment competition, give answers to questions about their risk, ambiguity level and their cognitive skills and played different games to measure their prudence and loss aversion level.

The followings are distinct human biases most commonly observed in financial decision making, that are measured in the experiment design:

- Self-assessment of willingness to take risks in general.
- Willingness of the person to take risks in financial decisions.
- Prudence level.
- Ambiguity aversion.
- Loss aversion

I have incorporated the data on human biases with the data on the demographic features of participants and tracked their portfolio choice in an investment competition for the period from March 6 to April 14 in 2017. The investment competition is containing several investment instruments covering both Istanbul Stock Exchange and VIOP and it is the Turkey's most comprehensive online investment contest. It has been designed by Bogazici University Economics and Management Club since 2015. I have created an incentivized subsample from participants of this competition to measure their risk-attitudes.

I observed that most of the measures are correlated with each other in different directions. The current study complements and extends previous literature by (i) using a large sample of students and real data from an investment competition, (ii) employing a comprehensive set of survey and experimental measures of risk attitudes, (iii) analyzing how these risk attitude measures proposed in the literature, relate to each other, to demographics and financial decisions, (iv) investigating the relation between higher order risk attitudes (prudence) and leveraged future contracts.

The remainder of the paper is designed as follows: Chapter 2 summarizes the previous literature on behavioral finance. Chapter 3 describes the experimental and survey design. Chapter 4 demonstrates the descriptive and empirical analysis of experimental results. Chapter 5 illustrates the different performance measurement techniques employed in this study. Chapter 6 indicates the relation between trading performance and different risk-attitude measurements. Chapter 7 presents conclusion and examination of the results.

CHAPTER 2

LITERATURE REVIEW

The traditional finance theory analyzes the financial markets and investor behavior based on individual's rationality assumption. There are two important characteristics of a rational investor: (i) she have a perfect information structure and she can make updates in this information set when she receives new information; (ii) her decisions in an investment can be justified by the society (Thaler, 2005). In 1980s it is argued that this rationality assumption is not reasonable and a new framework called Behavioral Finance occurred to take human behavior into consideration while analyzing investment behavior (Nofsinger, 2001). The Behavioral Finance literature addresses to clarify the possible reasons for inefficient financial markets. Behavioral Finance literature claimed that there should be change in two axioms of traditional finance theory (Kishore, 2004). To figure out possible reasons for individuals' irrationality, behavioral finance is based on experimental results to analyze biases that leads investor's decision making (Barberis & Thaler, 2003).

The investors in the real world and those who are supposed to be according to academic models are notably different from each other. According to traditional finance theory, individual investors have diversified portfolios to reduce their risks (Barber & Odean, 2013). However, most of the investors have under-diversified portfolio, generating high levels of idiosyncratic risks (Barberis & Thaler, 2003; Kaustia, 2010). Large number of empirical research provides evidence that investors trade so that at the aggregate level, this trade brings below-average long-run returns (Odean, 1999; Grinblatt & Keloharju, 2000).

The variation in performance of individual investors could be resulted from differences in financial and mental skills and sex (Barber & Odean, 2013). For the remaining of this part of the thesis, I will document findings of well-known researches for the possible reasons of this variation.

One of the reason for poor returns of individual investors is the "overconfidence" which lead to relatively high turnover rates (Moore & Healy, 2008). There are two types of overconfidence. First type is called as "overprecision", which means that a person believes that she or he knows more than the real knowledge level she/he has (Barber & Odean, 2013). Another variation for overconfidence is a thinking of being better than the average person identified as a "better-than- average" effect (Svenson, 1981; Barber & Odean, 2013). A considerable amount of research has developed a theoretical model based on the overconfident investors (Odean, 1998; Gervais & Odean, 2001; Caballe & Sakovics, 2003; Peng & Xiong, 2006).

In general, these models assume that some people feel overconfident while making their investment decisions about the accuracy level of their information and its scope, which in turn lead them to make excessive trading (Odean, 1999). This excessive trading brings lower performance (Barber & Odean, 2000). Barber and Odean (2001) claimed that it is more likely to be overconfident for a man than a woman , which lead them to make trading more, which brings lower trade performance.

Tversky and Kahneman (1979) have tried to explain decisions of individuals under uncertainty which was dominated by the Expected Utility Theory with an other framework called Prospect Theory. Expected Utility Theory claims that rational decision makers would have been indifferent between two prospects that brings the same expected utility. However, it has been proved construction of the problem affects

the individual's decision making (Tversky & Kahneman, 1981). Prospect theory demonstrates that preferences of individuals under the gain and loss situations are not symmetrical which can be interpreted as individuals are risk averse in the gain domain and risk lover in the loss domain (Kahneman & Tversky, 1979). Loss aversion which is very important in the economics and finance literature is firstly introduced (Tversky & Kahneman, 1979). Loss aversion means that people have more tendency to prefer avoiding losses rather than earning equivalent amount of gains. The so-called "loss aversion" behavioral bias is reflected itself as a "disposition effect" in the finance literature. Disposition effect means that retail investors are more willing to sell winning stocks (when their value increased since buying decision) instead of losing stocks (when their value decreased since buying decision) (Barber & Odean, 2013). The disposition effect of individual investors has been reported in different countries for different time periods (Grinblatt & Keloharju, 2001; Barber & Odean, 2004).

It is widely accepted that risk-averse investors should rely on a diversified portfolio so that they can reduce the idiosyncratic risk (Barber & Odean, 2013). However, findings of empirical research suggest that individual investors hold under-diversified portfolio (Goetzmann & Kumar, 2008; Mitton & Vorkink, 2007). The level of diversification raises with age, income, education (Goetzmann & Kumar, 2008). They find evidence that less diversification leads to lower return: annual returns of investors who are under-diversified are 2.4% lower than those of diversified investors. Furthermore, Goetzmann and Kumar (2008) suggest that investors having better diversified portfolios can also choose stocks bringing higher returns. Describing an individual as risk averse or risk-seeker is not a single method to identify his/her risk preferences.

Higher order risk preferences or perceptions also define people's risk preferences especially under uncertainty. The mostly observed type of higher order risk preferences or perceptions in the literature are prudence and temperance. Expected utility theory suggests that prudence and temperance relate to third and fourth derivative of utility function, respectively. The concept of prudence has been used in intertemporal risk preferences framework by Dreze and Modigliani (1972). In the economics literature, Kimball (1990) is the first one who defines the prudence in the context of precautionary savings against the uncertainty. This higher order risk preference is commonly used in the literature with several contexts: insurance under uncertainty and risks (Fei & Schlesinger, 2008) and investments decisions (Eeckhoudt & Gollier, 2005; Peter, 2017).

In order to model the degree of prudence and temperance a person has, Eeckhoudt and Schlesinger (2006) introduce a behavioral approach. This approach is applied in broader settings because both its applicability is simple and also it does not require any additional assumptions, as opposed to expected utility framework. This behavioral approach has been extensively used to model multivariate risk preferences (Eeckhoudt, Rey & Schlesinger, 2007) and ambiguity preferences (Baillon, 2017).

Noussair, Trautmann and Van de Kuilen (2013) applied this behavioral approach and conducted lab experiment to understand the distribution of prudence and temperance in student and general population. In addition to that, they examined how prudence and temperance have a connection with each other, with demographic features and with financial decision making. Their findings suggest that prudence is observed in both student and general population. Furthermore, it is more likely for people who are more prudent to have higher education and higher cognitive skills.

Findings regarding the literature of the relation between prudence and risk aversion is mixed: Some studies conclude strong and positive correlation between prudence and risk aversion (Ebert & Wiesen, 2014); some of them come up with no relation at all (Deck & Schlesinger, 2014). Baillon, Schlesinger and Van de Kuilen, (2018) suggest that at the aggregate level, temperance is not observed, which in turn provide strong evidence that great proportion of population is risk-lover.

CHAPTER 3

EXPERIMENTAL AND SURVEY DESIGN

Investimate, where only students (undergraduate and graduate) are allowed to participate, had started on 6 March 2017 and ended on 14 April 2017, which was managed by Bogazici University Economics and Management Club and sponsored by Istanbul Stock Exchange.

At the beginning of the contest, 100,000 Turkish Lira (TL) ($ 26,954 at the time of experiment) virtual money will be defined for each competitor and the contestants will carry out their transactions by using a software provided by private investment intermediary with this virtual money. During the competition, students were allowed to use half of this money for stocks and stock warrants transactions and the remaining half for derivatives. Transactions had occurred with the market prices provided by the Istanbul Stock Exchange. During these six weeks, 1,278 students from 142 different universities in Turkey participated the game through using their edu.tr e-mail addresses.

To introduce the experiment, a private financial intermediary, which develops and supports the online infrastructure of investment competition was connected. From the beginning of the competition, the study had been appeared immediately whenever participants log in their competition account. At the beginning of the study, participants were told there will be five parts in the study and before starting each task, they would be informed about what they were expected. They were informed that total study will last about 30 minutes and randomly chosen 50 participants who finished all tasks would gain a gift certificate worth 50 TL ($13.47 at the time of experiment) for a well-known bookstore.

The participants could click on a link that appeared on the screen when they tried to log in their account to finish all tasks in online platform. They had 40 days to take part in the experiment (from March 6 to April 14 including weekends). From the 1,278 contestants, 261 participants finished all tasks. When subjects clicked on link, they first noticed a page where they have to enter their e-mail address that is also used in the investment competition. After that, they were delivered to another page which indicated the directions for the competition. The study had five different tasks.

In the first task, participants were asked about their demographic characteristics including their gender, age and marital status and the following questions related to their risk attitudes:

- In general, how willing are you to take risks? (The subjects showed their responses on a scale of 0 to 10.)
- How much do you trust banks and other financial institutions? (The subjects showed their responses on a scale of 0 to 10.)

After these three questions were answered, the participants were required to answer the questions adopted from the financial risk tolerance scale to measure the willingness of the person to take risks in financial decisions. The measure consists of a 13-item investment risk-tolerance scale presented in the Appendix A. [1] This scale is one of the most important risk - preference evaluation tool available to consumers and researchers, which has no cost in application (Kuzniak, Rabbani, Heo, Ruiz-Menjivar & Grable, 2015).

[1]The scale is adapted from Grable and Lytton (1999) and the original text is translated into Turkish.

After completing the first task, on the new screen, participants were asked to answer the following three questions to measure their cognitive skills. The Cognitive Reflection Test (CRT) consists of three-item and it is introduced by Frederick (2005). This scale mainly measures the degree of resistance people can show to an impulse response which is most likely incorrect (Frederic, 2005). As can be seen in the following list, the item includes three mathematical problems which leads to an intuitive and incorrect response.

- A bat and a ball cost 1.10 dollar in total. The bat costs 1.00 dollar more than the ball. How much does the ball cost? ..... cents
- If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? ..... minutes
- In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? ..... days

Findings of several empirical research indicates that participants mostly find these problems difficult to solve and it is more likely for those who have higher CRT scores also to perform better at other ability tests (Frederick, 2005; Toplak, West & Stanovich, 2011).

In the third task, the study was replication of the game, which was introduced by Abdellaoui, Bleichrodt and l'Haridon (2008) and tested with a student sample. Under the assumptions of expected utility framework, people behave in a symmetric way in both gain and loss domain; however, utility measurements based on this framework lead to inconsistent results (Abdellaoui, Bleichrodt & Paraschiv, 2007).

Findings suggest that there seems to be different reasons for the deviation from the concept of expected utility: probability weighting and existence of loss aversion (Diecidue & Wakker, 2001; Tversky & Kahneman , 1992). The prospect theory is used to model probability weighting and loss aversion. However, there is also a problem for utility measurements and they do not take the probability weighting and loss aversion into consideration to measure utility (McCord & de Neufville, 1986).

Tversky and Kahneman (1992) imposed some parametric forms for probability weighting and utility function to estimate value of utility under prospect theory. Abdellaoui et al. (2007) offer another method to improve utility measurement. This nonparametric method provides an advantage: we do not have to make assumptions regarding utility function or probability weighting (Abdellaoui et al., 2008).

At the very beginning of the task, there was a statement which says that participants were required to make a selection among two prospects A and B which can include both gain and loss cases. Appendix B indicates two examples of the way that experiment questions are illustrated. The bisection process is explained in the Appendix C. [2] I adopted choice-based elicitation procedure similar to Abdellaoui et al. (2008).

I have used three certainty equivalence questions to elicit the utility function in the gain and three certainty equivalence questions to elicit the utility function in loss domain. Table 1 displays the prospects that I calculated certainty equivalents. To calculate the loss aversion coefficient, I chose G_1*, G_2*, G_3* and determined L_j* so that $(G_j^*, p_g; L_j^*) \approx 0$, j = 1,2,3.

[2]The bisection process is adapted from Abdellaoui et al. (2008).

Table 1. Prospects

	Outcome index i		
	(1)	(2)	(3)
$\|x_i\|$	10,000	6,000	8,000
$\|y_i\|$	0	4,000	2,000

The following task included a survey question based on the two-colour Ellsberg (1961) urn experiment. Under many situations, people have to make decisions under uncertainty, which means that decision-makers do not know probabilities of certain outcomes. The case where there is no definite information for the probabilities of outcomes is defined as ambiguity and it is corresponding to uncertainty which is different from standard concept of risk (Ellsberg ,1961).

Considering ambiguity aversion allows economists to analyze differences in decision-making that cannot be explained only with risk aversion. Large part of the literature tried to measure ambiguity aversion in incentivized laboratory environment, which is costly and complex in implementation (Cavatorta & Schröder, 2016). There exists two commonly implemented hypothetical thought experiments for measurement of ambiguity preferences (Cavatorta & Schröder, 2016).

I applied one of the hypothetical thought experiment, which is the replication of seminal two-colour Ellsberg (1961) urn experiment. There are five choices presented to participants and their preference for the ambiguous urn indicates the extent of of ambiguity aversion (Butler, Guiso & Jappelli, 2014). The task is presented in the Appendix D. [3]

[3]The task is adapted from Cavatorta and Schröder (2016) and original text is translated into Turkish.

The final task of the study is based on Noussair, Trautmann and Van de Kuilen (2013) whose aim is to measure prudence level and participants were presented with two options which are constructed as two stage lotteries (Eeckhoudt & Schlesinger, 2006). Risk attitudes in higher order have been investigated based on the expected utility theory (Kimball 1990).

The first stage of these lotteries is an equal chance of winning a high or low outcome and the second stage of these lotteries is a zero-mean risk lottery. However, in the first lottery, the second stage is realized only after high outcome in the first step and, in the second lottery, the second step is realized only after low outcome in the first lottery. A prudent individual would choose first lottery over second lottery whereas imprudent individual would prefer second to one.

The categorization of individual as prudent and imprudent is not dependent on the risky choice model (Bleichrodt & Eeckhoudt 2005). This method is both simple in application and also it can classify individual as prudent or imprudent regardless of he /she is expected utility maximizer. Following Eeckhoudt and Schlesinger (2006), the behavioral approach of prudence has been extensively used in the literature (Ebert & Wiesen , 2009). The task is presented in the Appendix E. [4]

[4]The task is adapted from Noussair et al. (2013) and original text is translated into Turkish.

CHAPTER 4

EMPIRICAL ANALYSIS: EXPERIMENTAL RESULTS

With this experimental design, besides the results of the study, I have information for the demographic features of the subjects. Although there are 1,278 participants in the investment competition, only for 261 participants, demographic information is available. Before making analysis, I removed upper and lower 1 percentile of two variables (willingness to take risks in financial decisions and loss aversion) from the data set. I make the analysis with these 261 individuals and I indicated the descriptive analysis on the demographics of subjects in Table 2.

Table 2. Descriptive Statistics on Demographics and Risk Attitudes

	Obs.	Percent	Mean	Std.Dev	Min	Max
Male	261	75				
Age	261		22	2.3	18	34
Single	261	99				
Self-reported willingness to take risks	261		6.27	2.5	1	9
Willingness to take risks in financial decisions	261		30.21	4.32	20	41
Trust to financial institutions	261		5.103	2.809	0	9
Cognitive reflection test	261		2.16	0.909	0	3
Loss Aversion level	261		2.06	2.73	.017	20.17
Ambiguity Aversion level	261		3.35	1.33	1	5
Prudence level	261		3.65	1.36	0	5

The majority of subjects were males (75 percent of our sample) and the because sample consists of students from different universities, the average age was 22 and 99 percent of participants were single.

In the data, I have two different measurement of individual risk attitudes: self-reported willingness to take risks in general, willingness of the person to take risks in financial decisions. The overall mean value of the first one is 6.27 with a standard deviation of 2.5. For the second one, the overall mean value is 30. 21 with a standard deviation 4.32. Scores from the test range from 13 to 47 meaning that

increase in the score means the increase in the risk-tolerance. Those with scores which are 18 or below is interpreted as low risk tolerance and ones which are 33 or above is interpreted as high risk tolerance. Kuzniak et al. (2015) documented a meta-analysis by using the response data from over 160,000 individuals, for the period between late 2007 and 2013. The sample can be regarded as more risk-lover as compared to results of this meta-analysis, reporting the mean value as 27.53 and standard deviation as 5.48. The distributions of these two risk measurements are illustrated in Figure 1 and Figure 2, respectively.

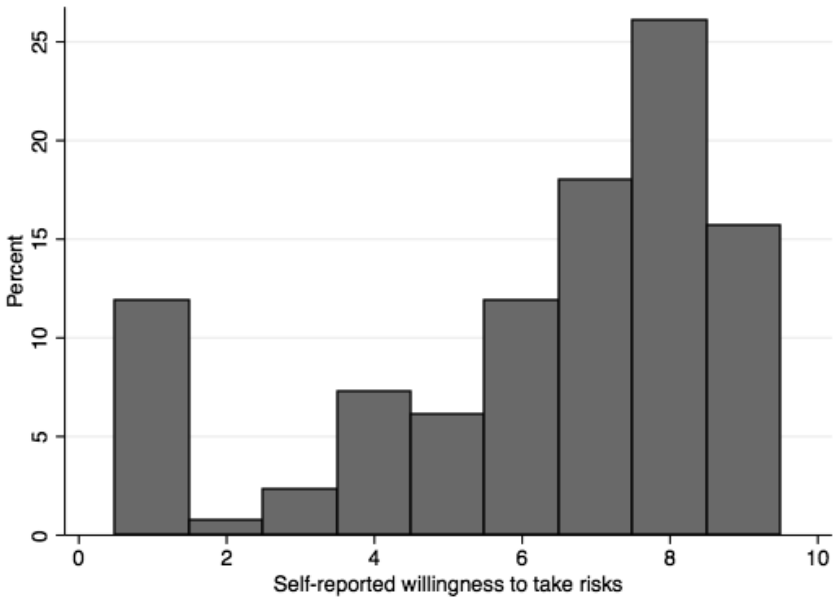

Figure 1. Histogram for the self-reported willingness to take risks in general

For the cognitive reflection test, I have the CRT values according to participant's number of correct choices in the test. The key point in these questions is that an impulse and quick answer comes to mind; however, this impulse answer is incorrect. (Frederick, 2005). The mean value of the CRT in this sample is 2.16, which is higher than the results of Frederick (2005) conducting the CRT with undergraduate students at different universities. The histogram for this measure is presented in Figure 3.

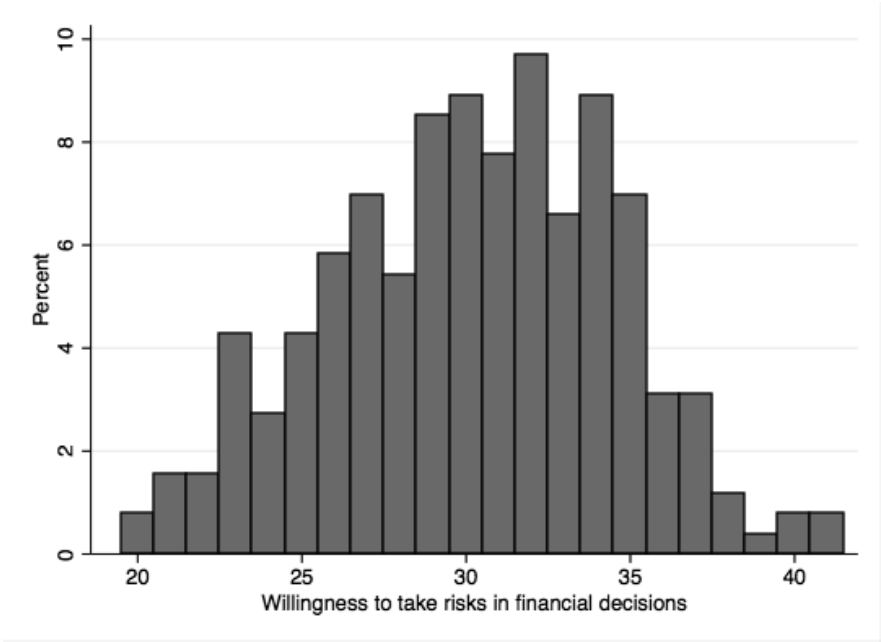

Figure 2. Histogram for willingness to take risks in financial decisions

A pioneering study of Ellsberg (1961) has questioned both rationality assumptions and preestablished models of choice under uncertainty. Remember that, participants were required to answer a question and as the choice of the subject is closer to the option of choosing the ball from the second urn, then he/she has been regarded as having more “ambiguity averse preferences”.

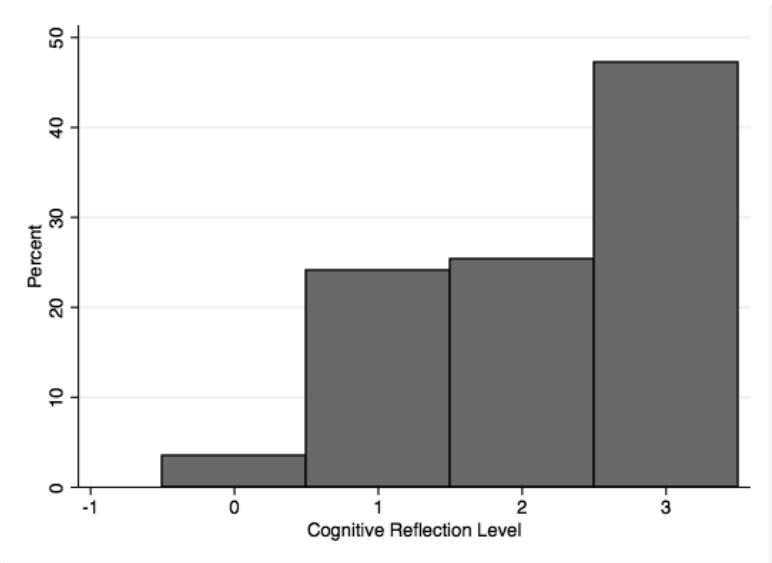

Figure 3. Histogram for cognitive reflection level

The value of ambiguity aversion is between 1 (least ambiguity averse) and 5 (most ambiguity averse), and in this sample it has a average value of 3.35, which is lower than the value reported by Cavatorta and Schröder (2016) who developed an ambiguity preference survey module (see the histogram in Figure 4). Thus, I can observe that in the sample, overall mean value for willingness to take risks in financial decisions is 30.21, which is above the mean value calculated in the meta-analysis therefore the sample can be regarded as more risk-lover compared to whole population. Furthermore, the sample can be considered as less ambiguity-averse. Related to this issue, there exists some research investigating the relation between risk-aversion and ambiguity aversion.

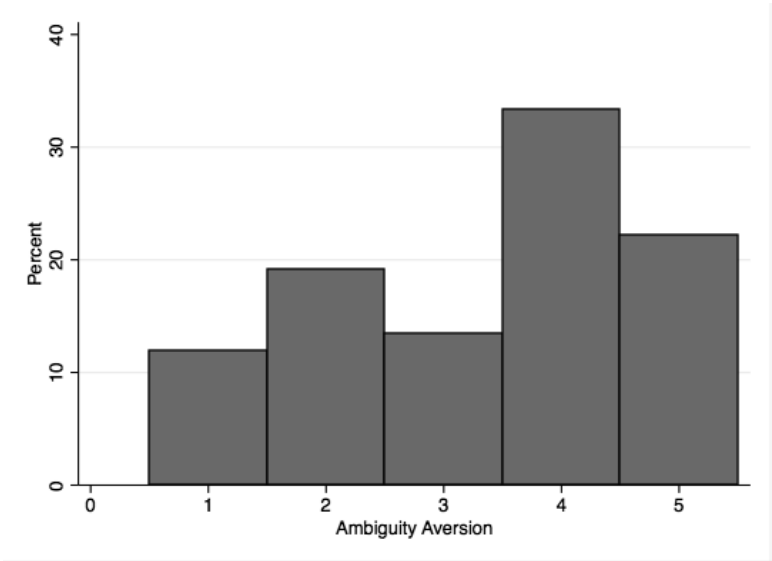

Figure 4. Histogram for ambiguity aversion level

Chen and Epstein (2002) applied a model to understand the equity premium puzzle and they concluded that equity premium consists of two positive factors: one resulting from the risk aversion and the other coming from the ambiguity aversion. Findings regarding the relation between risk aversion and ambiguity aversion are mixed. Klibanoff, Marinacci and Mukerji (2005) conclude that ambiguity aversion

can be regarded as an extra risk aversion. Thus, results indicate that in this sample, risk-aversion and ambiguity aversion do not strengthen each other, which is a contributed the mixed result in previous studies. However, Gollier (2006) concluded that ambiguity aversion can increase the interest in the risky product and decrease in the demand for unambiguous product.

Although the analysis of risk attitudes has been mostly focused on the measurement of risk aversion, risk attitudes in higher orders also have an impact on financial decisions. Noussair et al. (2013) investigated higher order risk attitudes for a large sample and also student sample. They conducted a lab experiment where participants make a choice between pairwise lotteries developed by Eeckhoudt and Schlesinger (2006). They have analyzed the relation between demographic characteristics of participants and their prudence and temperance level to figure out whether the results of previous studies could be generalized into large number of people. They find that participants from both sample groups are prudent. The prudence measure is between 0 (least prudent) and 5 (most prudent), and in the sample it has an average value of 3.65, which concludes that the sample can be considered as more prudent compared to prudence level of 3.45 in Noussair et al.(2013) (a histogram is illustrated in Figure 5).

Finally, for the loss aversion measure, I have categorized each participant according to two classification ways. I have adopted power utility function for gain and loss domain. The utility function in gain domain is described as x^{α} and for losses as x^{β} with α , β >0. For gains (losses), the power utility function is classified as concave when α <1 (β >1), as linear when α $=1$ (β=1), and as convex when α >1 (β <1).

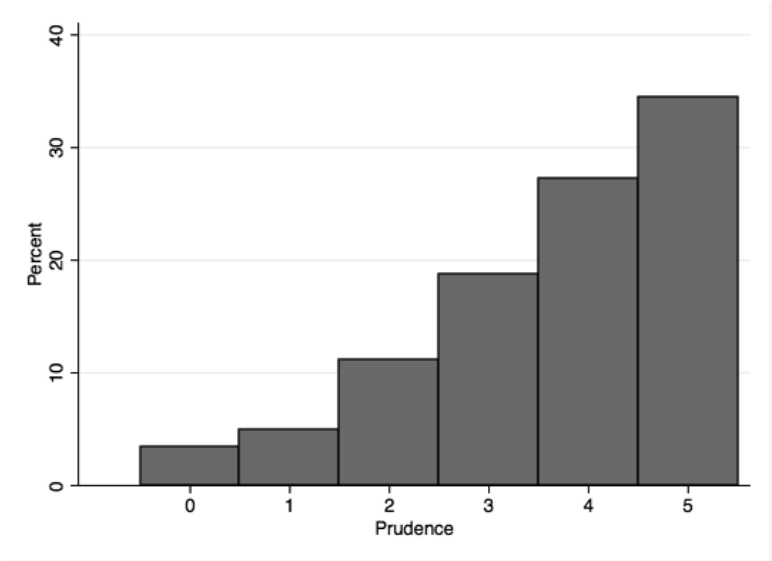

Figure 5. Histogram for prudence level

Firstly, I classify participants according to form of their utility function in the loss and gain domain. Preferences of the subject is classified as concave (convex) in the gain domain when the power estimation from the utility function for gains was smaller than (bigger than) 1. In the loss domain, a participant was identified as convex (concave) if the power estimation from the utility function for losses was smaller than (bigger than) 1 (see Table 3).

The mostly observed shape was convex utility in the gain domain and convex utility in the loss domain; whereas in the article (Abdellaoui et al., 2008), the mostly observed shape was concave utility function in both of domains. Then, I classified the subjects according to magnitude of the certainty equivalent proportional to expected value of the prospect. The individual can be classified as risk-averse, risk-neutral and risk-seeker according to the distance between certainty equivalent he/she obtains at the end of the experiment and the expected values of the prospect that is indicated in the experiment. Then, I can analyze if there is one-to-one relation between the shape of the utility function and risk attitude of subject.

Table 3. Classification of Subjects According to Power Estimations

		Losses			
		Concave	Convex	Linear	Total
Gains	Concave	38	33	14	85
	Convex	52	90	16	158
	Linear	1	3	14	18
	Total	91	126	44	261

An individual was classified as risk averse when the the certainty equivalent was smaller than the expected value of the prospect, as risk neutral when the certainty equivalent was equivalent to the expected value and as risk lover when the certainty equivalent was greater than expected value (see Table 4).

Table 4. Classification of Subjects for Risk Attitude

			Losses	
		Risk Averse	Risk Seeking	Total
Gains	Risk Averse	47	91	138
	Risk Seeking	46	77	123
	Total	93	168	261

Risk aversion is the most dominant for gain domain and risk seeking was most common pattern for loss domain, which is confirming the classical predictions of the Prospect Theory. The detailed correlation analysis for each subgroup is available in Appendix F. However, I can observe that under the prospect theory, the convex utility function and risk-averse behavior under the gain domain can occur simultaneously. In Table 5, the correlations between different risk preference measurements employed in this study are presented.

Table 5. Spearman Correlation Matrix: Risk Attitude Measures

	Self-reported	Trust-banking	Trust-people	Rutgers	Crt	Amb. Avers	Prudence	Loss aversion
Self-reported	1							
Trust-banking	0.4204***	1						
Trust-people	0.0479	0.1162*	1					
Rutgers	0.2387***	-0.0481	-0.0731	1				
Crt	0.0718	0.0959	0.0236	-0.0722	1			
Amb. Avers	-0.0335	-0.0046	0.0236	-0.0492	0.0721	1		
Prudence	0.0242	0.0636	-0.0317	-0.0259	0.2505***	0.0219	1	
Loss aversion	0.0429	-0.0486	-0.0605	0.3534***	-0.1804***	-0.0259	-0.1601**	1

Note: ***, **,* indicate significance levels at 1 percent, 5 percent and 10 percent respectively.

Unsurprisingly, I found a strong positive correlation between self-willingness to takes risks and the extent of risk-taking for financial decisions. Other than this, empirical analysis indicates that participants having more cognitive skills have more tendency to be prudent but less likely to be loss averse. In addition to that, the highest correlation between distinct measures is discovered between the willingness to take risks in financial decisions and loss aversion. This means that participants who are more risk-seeker are more likely to be loss averse.

To further elaborate the determinants of different risk attitudes and to acquire partial correlations, I conduct an OLS regression for different risk-attitude measures on some of demographic features and other measures retrieved from the experiment. Regression results are displayed in Table 6. I use gender, cognitive reflection level, level of trust in financial institutions- as regressors. The results have similar implications as compared to results provided by the Spearman correlations. Within the four measures of risk attitudes, none of them fails to F-test other than the ambiguity aversion.

Table 6. Determinants of Risk Attitudes (OLS Regression)

	Rutgers	Loss aversion	Ambiguity aversion	Prudence
Gender (Male =1)	1.1736*	-0.867**	-0.1109	-0.075
	(0.627)	(0.392)	(0.195)	(0.196)
Crt	-0.339	-0.5817***	0.111	0.3256***
	(0.185)	(0.186)	(0.092)	(0.093)
Trust-bank	-0.258**	0.015	0.0045	0.0164
	(0.115)	(0.072)	(0.036)	(0.036)
Constant	28.446***	3.684***	3.33***	2.953***
	(0.977)	(0.616)	(0.304)	(0.306)
N.of.Obs	258	258	258	258
F-statistic	3.10	4.11	0.54	3.08
Prob >F	0.0151	0.0020	0.7043	0.0135
R-squared	0.0585	0.0721	0.0043	0.0449

Note: Robust standard errors are in parenthesis. (***), (**) and (*) indicate significance at 0.01, 0.05 and 0.1, respectively.

First, the results indicate that males are more risk seeker and less loss averse as compared to females, holding other variables constant. Women have more tendency to be risk-averse than men, which has the same predictions with the literature (Barber & Odean, 2001). There seems to be no gender differences regarding ambiguity aversion and prudence. This analysis shows that men and women behave differently if they have a right to avoid risk. If a safe option is not present, then gender differences do not have a significant effect. As expected and observed from correlation analysis, self willingness to take risks has been a sound predictor for risk preference and perception for financial decisions. Second, the increase in the cognitive reflection level of participants has a negative impact on loss aversion, which can be interpreted as those having higher cognitive reflection skills tend to be less loss averse. Contrary to loss aversion, scores of CRT appears to be positively related to prudence. This means that those with higher cognitive skills indicate an increased tendency to put unavoidable risks

to the case where they have higher wealth. This observation also suggests that it is possible for an individual to modify their response to unavoidable risk by increasing his/her cognitive skills.

CHAPTER 5

TRADING AND INVESTMENT PERFORMANCE MASURES

I track trading activity for 1,278 participants for the investment competition. I classified them into two different groups: those who made transactions in stock and warrant market and in derivative market. Thus, there are 1,238 participants for the first group and 604 participants for the second group.

5.1 Stock market participants

I analyzed the investment performance of participants based on several portfolio performance measures including portfolio return, volatility and realized alpha and beta values. The data consists of trading activities (buying and selling decisions) of participants both in stock and derivative market at a daily frequency.

Firstly, I strike a net asset values (NAV) of each position taken in each portfolio and also any cash flows for time periods of the competition. Daily return of a participant in stock market is determined by carrying the overall portfolio values of the participant for each day and then calculating the percentage difference from period to period of this overall portfolio value.

Overall portfolio values consists of two parts: (i) the remaining cash balance of the participant as a result of buying and selling decision, (ii) the return of the stock at that day: if the stock is bought then its return is calculated relative to its closing price and if the stock is sold then its return is calculated relative to its buying price. After I calculated the daily return of each portfolio, I calculated cumulative returns of a participant to measure the overall performance of a portfolio. I calculated the

portfolio volatility by using the standard deviation of each portfolio, then aggregated by multiplying with $\sqrt{252}$. Portfolio skewness and kurtosis are calculated in a similar manner. Diversification means that how many different stocks that a participant holds in her portfolio throughout the competition. The portfolio alpha and beta are found by utilizing CAPM model:

$$R_{j,t} - R_{f,t} = \alpha_j + \beta_j [R_{m,t} - R_{f,t}] + \varepsilon_{j,t} \tag{1}$$

Table 7 illustrates the summary statistics of investment performance indicators for stock market participants.

Table 7. Investment Performance: Stock Market Participants

Variable	#ofObs.	Mean	Std.Dev	Min	Max
Return	1,238	0.06	0.143	-0.41	1.64
Diversification	1,238	9.29	10.09	1	85
Volatility	1,238	0.23	0.16	0.0000128	0.98
Skewness	1,238	0.96	2.06	-5.2947	5.29
Kurtosis	1,238	9.47	6.71	1.7	29.03
Alpha	1,238	0.00145	0.004134	-0.0162	0.033
Beta	1,238	0.0023	0.004	-0.03	0.021

To compare portfolio performance, I used BIST100 index return for the period of competition as a benchmark index. I observe that the average return of traders is 6% which is higher than benchmark return with an average return 3%. Furthermore, the average skewness of traders is lower than the benchmark (1.43) ; while average kurtosis of traders is higher than the benchmark (4.54). Finally, the average Jensen's alpha of traders is positive, meaning that for the period of investment competition, average trader earned more than enough return to be compensated for the risk she

takes. Moreover, the average beta of traders is also positive but less than 1 indicating that the average portfolio is less risky than the benchmark index.

5.2 Derivative market participants

Participants make transactions in derivative market with future contracts, which provides an obligation to buy or sell a particular commodity or financial instrument including precious metal and foreign exchange at a predetermined price at a specified time in the future. There are four main elements in futures contracts:

- Maturity date
- Quantity (Contract Size)
- Quality (Asset Class)
- Price

During the investment competition, participants could make future contracts whose underlying asset may be foreign exchanges including USD/TL, EURO/TL, golden and BIST30 index. Initial margin is the lowest required amount that investor must have in her account to make a purchase or sale transaction. Under the heading of Istanbul Stock Exchange, every future contract has different initial margin. Among those contracts that participants make transactions, future contract that requires least initial margin is the golden. In the future contracts, I calculated profit or loss on a daily basis according to ”settlement price” and reflected in the relevant accounts.
A settlement price is the price that is used to calculate temporary profit and loss for each day as well as to adjust margin requirements. This price may be different from

the closing price. My calculation is based on the mark-to-market approach. The daily profit or loss values of the participants holding open positions is calculated as follows:

- At the end of the first trading day: The difference between the price of the transaction and the settlement price is taken as basis.
- On the following days: The distinction between the settlement price of the previous day and the current settlement price is taken as basis.

The volatility, skewness and kurtosis values of each portfolio are calculated in a similar manner I did for the stock market participants. Finally, future contracts has a leverage system that allows investors to make transactions whose value is above the total amount of investment. Leverage is a useful tool for trading, allowing small traders to open up large volume transactions, but it also makes it necessary to develop an accurate risk management strategy when trading because of the high risk involved. I used the following formula to calculate the leverage rate:

$$\text{Leverage} = \text{Contract Value (Price x Size)}/\text{Initial Margin} \tag{2}$$

The leverage ratio varies according to the price of the contract and margin requirements determined by the İstanbul Stock Exchange. Table 8 illustrates the contract size, initial margin and approximate leverage ratio of future contracts determined by the Istanbul Stock Exchange. These are not all future contracts that are bought/sold under the İstanbul Stock Exchange, however, it is the list of contracts that are allowed to be transacted throughout the competition.

Table 8. Future Contracts in the Investment Competition

Future Contract	Contract Size	Initial Margin	Leverage Ratio
USD/TL	1,000 USD	190 TL ($ 51.21)	01:20
EURO/TL	1,000 EURO	230 TL ($ 61.99)	01:19
Golden	1 Gram	15 TL ($ 4.04)	01:10
BIST30	100 (Index/1,000*100)	1,120 TL ($ 301.88)	01:12

Table 9 illustrates the summary statistics of investment performance indicators for derivative market participants.

Table 9. Investment Performance: Derivative Market Participants

Variable	#ofObs.	Mean	Std.Dev	Min	Max
Leverage	604	14.9	3.22	9.75	19.99
Skewness	604	0.033	2.16	-5.2947	5.29
Kurtosis	604	9.466	7.03	2.276	29.03
Return	604	-0.018	0.275	-0.77	1.48
Volatility	604	0.051	0.034	0.000009	0.1316

When I compare portfolio performance of stock market and derivative market participants, I observe that the average return in the derivative market is negative, which is less than the average return in the stock market. Furthermore, the average skewness of stock market traders is higher than that of derivative market traders ; while average kurtosis of traders in both groups is almost the same. Finally, the average volatility is higher for stock market participants. As mentioned, different from stock market transactions, traders in the derivative market can make leveraged future contracts. The average of leverage ratio is almost 15, which is appropriate to the rules of future contracts determined by the İstanbul Stock Exchange.

CHAPTER 6

INVESTMENT PERFORMANCE AND RISK ATTITUDES

To understand the relation between portfolio choice and risk attitudes, I create two different subgroups from all participants:

- 258 participants of stock market participants completed full test of tasks.
- 140 participants of derivative market participants completed full test of tasks.

Table 10 and Table 11 illustrate the correlation analysis of risk attitudes and portfolio choice of stock market and derivative market participants respectively.

Table 10. Correlation Analysis of Stock Market Participants

	Cum. Return	Divers	SD	Skew.	Kurtosis	Alpha	Beta	Selfreported	Rutgers	CRT	Amb. Avers.	Prudence	Loss aversion
Cum. Return	1												
Divers	0.6***	1											
SD	0.527***	-0.45***	1										
Skew	0.365***	0.1016	-0.1936***	1									
Kurtosis	-0.177***	-0.1273**	-0.1579**	0.439***	1								
Alpha	0.99***	0.6037***	0.5405***	0.355***	-0.169***	1							
Beta	0.0021	0.0511	0.1789***	-0.0618	-0.178***	-0.0233	1						
Selfreported	-0.0698	-0.1162*	-0.0066	-0.0813	0.108*	-0.0693	0.0699	1					
Rutgers	0.027	0.0025	0.1424**	-0.0545	-0.088	0.0301	0.0411	0.2335***	1				
CRT	-0.0493	-0.0278	-0.043	0.126**	0.0522	-0.0558	0.0653	0.0586	-0.0791	1			
Amb. Avers.	-0.0514	-0.0219	-0.0617	0.0908	0.1264**	-0.0527	-0.015	-0.0288	-0.0469	0.0764	1		
Prudence	0.0582	0.0074	0.0233	0.0303	0.046	0.0572	0.0072	0.0311	-0.023	0.2582***	0.0208	1	
Loss aversion	-0.0476	-0.1026	-0.0508	-0.0277	0.0508	-0.0421	-0.0564	0.0362	0.3518***	-0.188***	-0.024	-0.155**	1

Note: ***, **,* indicate significance levels at 1 percent, 5 percent and 10 percent respectively.

The analysis indicates that participants who reported themselves as more risk-seeker have less diversified portfolio. The research related to the under-diversified portfolios provides several explanations. The possible reasons for under-diversified portfolio are transaction costs (Merton, 1987), financial illiteracy and insufficient information for investment opportunities (Goetzmann & Kumar, 2008). Other than

factors mentioned above, individual risk attitudes also have an effect on the portfolio composition. Intuitively, individual's risk aversion and a preference for an under-diversified portfolio are negatively correlated. This conclusion can be inferred from the fact that investors can decrease the portfolio risk through allocation of their wealth to a large number of assets (Markowitz, 1952).

Furthermore, as expected, portfolio variance decreases with more diversified portfolios because modern portfolio theory suggests that portfolio variance or volatility can be declined by selecting assets which have low or negative correlation with each other (Markowitz, 1952). Moreover, I can observe that participants who asses themselves as more risk-seeker in financial decisions have more volatile portfolios. This means that more risk-averse investors tend to have a portfolio with lower standard deviation. Thus, it can be concluded that self reported risk attitudes accurately predict the actual investment behavior as in the previous literature (Corter & Chen, 2006).

Table 11. Correlation Analysis of Derivative Market Participants

	Leverage	Skew.	Kurtosis	Selfreported	Rutgers	CRT	Amb. Avers.	Prudence	Loss aversion
Leverage	1								
Skew.	-0.024	1							
Kurtosis	-0.1306	0.1344	1						
Selfreported	0.187**	0.2171**	-0.0186	1					
Rutgers	-0.0272	0.226***	-0.1631*	0.2637***	1				
CRT	0.0003	0.105	0.1823**	-0.0391	0.0266	1			
Amb. Avers.	0.0261	0.0489	-0.0048	-0.0102	0.0355	0.1955**	1		
Prudence	0.1479*	-0.0323	-0.0909	-0.0057	-0.037	0.2278***	0.0942	1	
Loss aversion	-0.1391	-0.1107	-0.1338	0.0027	0.3634***	-0.2521***	-0.1227	-0.1707**	1

Note: ***, **,* indicate significance levels at 1 percent, 5 percent and 10 percent respectively.

Results indicate that subjects who are more risk-seeker have higher leveraged portfolios. Leverage allows the investor to involve with higher volume transactions

with less capital. In finance, leveraged transactions result in higher capital gains or losses than spot transactions based on the risk taken by the investor. Leverage and risk are directly proportional. Thus, my conclusion confirms the classical relation between risk-attitudes and leverage ratio.

CHAPTER 7

CONCLUSION

In this study, I analyze the risk preferences of participants of an investment competition. The main aim of this study is to experimentally test how different risk-attitude measurements have a relation with each other, with demographic features and with risk attitudes and preferences in an investment competition. I conducted this experiment with participants who also made investment decisions in stock and derivative markets during six weeks, using a software provided by private investment intermediary with the market prices provided by the Istanbul Stock Exchange. The experiment consists of five tasks to identify different risk preferences of participants: self-reported willingness to take risks in general and in financial domain, prudence level, ambiguity aversion and loss aversion level.

As compared to previous studies regarding measurements of risk attitudes, the sample can be categorized as exhibiting lower risk-aversion, higher loss-aversion, higher ambiguity-aversion and higher prudence. With the results of the third task, I firstly classified participants according to their utility function and its form for the loss and gain domain. The mostly observed example was convex utility in gains and loss domains. Then, I classified the subjects according to magnitude of the certainty equivalent relative to expected value of the prospect. Risk aversion was mostly observed preference for the gain domain, on the other hand, risk seeking was more prominent for the loss domain, confirming the classical predictions of the Prospect Theory.

Next, I analyzed the relationship between different risk-attitude measurements. Unsurprisingly, I found a strong positive correlation between self-willingness to takes risks and the extent of risk-taking for financial decisions. Other than this, empirical

analysis indicates that participants having a higher cognitive skills have more tendency to be prudent but less likely to be loss averse. In addition to that, the highest correlation between distinct measures is discovered between the self-reported willingness to take risks and loss aversion.

Having described different measures of risk preference and perceptions (self-reported willingness to take risks, willingness to take risks in financial decisions, ambiguity aversion, loss aversion and prudence level) obtained through survey and experiments, the following step was to calculate measures for risk and return levels of participants.

Firstly, I divided the transactions data of participants into the two different groups: stock market transactions and leveraged future contracts transactions. For each group, I calculated daily returns of investors and different portfolio risk measurements including Sharpe ratio, alpha and beta. My aim was to compare risk attitudes and portfolio returns of participants for stock and leveraged future contracts. Modern Portfolio Theory is one of the most significant finance theories dealing with investment (Markowitz, 1952). The theory is based on the idea that investors can reduce unsystematic risks in a portfolio through diversification. I found that for the stock market transactions, there exists strong and positive correlation between being risk averse and loss averse and having a diversified portfolio. This means that the more risk lover participant, the less diversified portfolio he/she has. Furthermore, for the derivative market transactions, correlations show that participants who can be categorized as more risk lover and more prudent would be more willing to take higher leverage in future contacts.

APPENDIX A

FINANCIAL RISK TOLERANCE SURVEY

1. In general, how would your best friend describe you as a risk taker?

   (a) A real gambler

   (b) Willing to take risks after completing adequate research

   (c) Cautious

   (d) A real risk avoider

2. You are on a TV game show and can choose one of the following. Which would you take?

   (a) $1,000 in cash

   (b) A 50 percent chance at winning $5,000

   (c) A 25 percent chance at winning $10,000

   (d) A 5 percent chance at winning $100,000

3. You have just finished saving for a “once-in-a-lifetime” vacation. Three weeks before you plan to leave, you lose your job. You would:

(a) Cancel the vacation

(b) Take a much more modest vacation

(c) Go as scheduled, reasoning that you need the time to prepare for a job search.

(d) Extend your vacation, because this might be your last chance to go first-class

4. If you unexpectedly received $20,000 to invest, what would you do?

(a) Deposit it in a bank account, money market account, or an insured CD

(b) Invest it in safe high quality bonds or bond mutual funds

(c) Invest it in stocks or stock mutual funds

5. In terms of experience, how comfortable are you investing in stocks or stock mutual funds?

(a) Not at all comfortable

(b) Somewhat comfortable

(c) Very comfortable

6. When you think of the word “risk” which of the following words comes to mind first?

(a) Loss

(b) Uncertainty

(c) Opportunity

(d) Thrill

7. Some experts are predicting prices of assets such as gold, jewels, collectibles, and real estate (hard assets) to increase in value; bond prices may fall, however, experts tend to agree that government bonds are relatively safe. Most of your investment assets are now in high interest government bonds. What would you do?

(a) Hold the bonds

(b) Sell the bonds, put half the proceeds into money market accounts, and the other half into hard assets

(c) Sell the bonds and put the total proceeds into hard assets

(d) Sell the bonds, put all the money into hard assets, and borrow additional money to buy more

8. Given the best and worst case returns of the four investment choices below, which would you prefer?

(a) $200 gain best case; $0 gain/loss worst case

(b) $800 gain best case; $200 loss worst case

(c) $2,600 gain best case; $800 loss worst case

(d) $4,800 gain best case; $2,400 loss worst case

9. In addition to whatever you own, you have been given $1,000. You are now asked to choose between:

(a) A sure gain of $500

(b) A 50 percent chance to gain $1,000 and a 50 percent chance to gain nothing

10. In addition to whatever you own, you have been given $2,000. You are now asked to choose between:

(a) A sure loss of $500

(b) A 50 percent chance to lose $1,000 and a 50 percent chance to lose nothing

11. Suppose a relative left you an inheritance of $100,000, stipulating in the will that you invest ALL the money in ONE of the following choices. Which one would you select?

(a) A savings account or money market mutual fund

(b) A mutual fund that owns stocks and bonds

(c) A portfolio of 15 common stocks

(d) Commodities like gold, silver, and oil

12. If you had to invest $20,000, which of the following investment choices would you find most appealing?

(a) 60 percent in low-risk investments 30 percent in medium-risk investments 10 percent in high-risk investments

(b) 30 percent in low-risk investments 40 percent in medium-risk investments 30 percent in high-risk investments

(c) 10 percent in low-risk investments 40 percent in medium-risk investments 50 percent in high-risk investments

13. Your trusted friend and neighbor, an experienced geologist, is putting together a group of investors to fund an exploratory gold mining venture. The venture could pay back 50 to 100 times the investment if successful. If the mine is a bust, the entire investment is worthless. Your friend estimates the chance of success is only 20 percent. If you had the money, how much would you invest?

(a) Nothing

(b) One month's salary

(c) Three month's salary

(d) Six month's salary

Scoring

1. a = 4; b = 3; c= 2; d = 1
2. a= 1; b= 2 ; c= 3 ; d= 4
3. a = 1; b= 2; c= 3; d =4
4. a = 1; b= 2; c= 3
5. a =1 ; b= 2 ; c= 3
6. a =1 ; b= 2 ; c= 3 ; d= 4
7. a= 1; b= 2 ; c= 3 ; d= 4
8. a =1 ; b= 2 ; c= 3 ; d= 4
9. a= 1 ; b= 3
10. a =1 ; b= 3
11. a =1 ; b= 2 ; c= 3; d = 4
12. a= 1; b= 2; c =3
13. a =1 ; b= 2 ; c= 3 ; d= 4

APPENDIX B

ILLUSTRATION OF QUESTIONS FOR LOSS AVERSION

Figure B1. Illustration of a task in the gain domain

Figure B2. Illustration of a task in the loss domain

APPENDIX C

EXPLANATION OF THE BISECTION METHOD

C.1 Bisection method

Table C indicates the bisection method we have adopted to produce indifference values for G_1 for p_g = 1/2. Bold printed values correspond to the prospect that is selected by the participant. The prospects have to yield equal expected value before starting the iterations. The outcome in each new iteration has changed depending on the values chosen. I have used four iterations while eliciting the utility function in the gain and loss domain.

Table C. An Illustration of the Bisection Method

Iteration	Offered choices in elicitation of G_1
1	**5,000** vs. (2,000, 1/2; 8,000)
2	**3,500** vs. (2,000, 1/2 ; 8,000)
3	2,750 vs. (**2,000, 1/2 ; 8,000**)
4	**3,125** vs. (2,000, 1/2 ; 8,000)
Indifference Value	3,968.75

C.2 Utility and probability weighting for gains and losses

During the elicitation process, the overall utility that prospect yields depends of three functions: a probability weighting function w^+ for gains, a probability weighting function w^- for losses, and a utility function U. The assumptions regarding *probability weighting functions* w^+ and w^- and *utility function* U are as follows:

- The probability weighting functions are increasing in a strict sense and it is ensured that they will satisfy the following conditions:

$w^+(0)$ =$w^-(0)$= 0 and $w^+(1)$ = $w^-(1)$ = 1

- The utility function U is strictly increasing and satisfies U(0)=0
- We assumed that there are two utility types: (i) a *basic utility function* u (Köbberling & Wakker, 2005). (ii) an observable utility function U that is consisting of both a loss aversion coefficient $\lambda \succ 0$ and basic utility u. This assumption can be reflected as:

$$U(x) = \begin{cases} u(x) & if x \geq 0 \\ \lambda u(x) & if x \leq 0 \end{cases} \tag{3}$$

Under prospect theory, gain prospects and and loss prospects (x, p; y) are calculated with following equations respectively:

$$w^+(p)(U(x) - U(y)) + U(y) \tag{4}$$

$$w^-(p)(U(x) - U(y)) + U(y) \tag{5}$$

C.3 Elicitation method

Firstly, I elicited the utility function for the gain domain, then it is elicited for the loss domain. For the loss and gain domain, I adopted the power utility function. Firstly, consider the utility elicitation for the gain domain. I chose the probability, which is constant. I selected an array of gain prospects (x_i, p_g; y_i), i=1,...,k. and draw out their certainty equivalents G_i.

By combining equations 1 and 3, I have the following equations:

$$U(G_{\mathrm{i}}) = \delta^{+}(u(x_{\mathrm{i}}) - u(y_{\mathrm{i}})) + u(y_{\mathrm{i}}) \tag{6}$$

$$G_{\mathrm{i}} = u^{-1}(\delta^{+}(u(x_{\mathrm{i}}) - u(y_{\mathrm{i}})) + u(y_{\mathrm{i}})) \tag{7}$$

where $\delta^{+} = w^{+}$ ($\mathrm{p_g}$). The utility function for gains is defined as x^{α} so that equation 7 can be estimated by nonlinear least squares. Then,

$$G_{\mathrm{i}} = (\delta^{+}({x_{\mathrm{i}}}^{\alpha} - {y_{\mathrm{i}}}^{\alpha}) + {y_{\mathrm{i}}}^{\alpha})^{\frac{1}{\alpha}} \tag{8}$$

where α and δ^{+} are two specifications that will be predicted with the econometric methods. The parameter α is related to the utility function's curvature and δ^{+} indicates the effect of probability weighting at probability $\mathrm{p_g}$.

I followed similar procedure to elicit utility in the loss domain. I chose $\mathrm{p_l} = 1 - \mathrm{p_g}$. I selected an array of loss prospects ($\mathrm{x_i}$, $\mathrm{p_l}$; $\mathrm{y_i}$), i=1,...,k. and draw out their certainty equivalents $\mathrm{L_i}$ where $0 \geq \mathrm{y_i} \geq \mathrm{x_i}$. By combining equations 1, 2 and 3:

$$L_{\mathrm{i}} = u^{-1}(\delta^{+}(u(x_{\mathrm{i}}) - u(y_{\mathrm{i}})) + u(y_{\mathrm{i}})) \tag{9}$$

where $\delta^{-} = w^{-}$ ($\mathrm{p_g}$). The utility function for losses is defined as x^{β} so that equation 9 can be estimated by nonlinear least squares.

C.4 Measuring loss aversion

The final step in the elicitation procedure is to generate a connection between utility function for both gain and loss domains thus calculate the loss aversion parameter λ. I can do this by an elicitation of only one indifference value. I selected a G* from the interval (0, x_k] and then determine L* so that (G*, p_g; L*) $\approx$ 0. Loss aversion was calculated by the following equation:

$$\delta^{+}u(G*) + \delta^{-}\lambda u(L*) = u(0) = 0 \tag{10}$$

δ^{+}, u(G*), δ^{-} and u(L*) parameters that are known through the nonlinear least square estimation of Eqs. 7 and 9 thus Eq. 10 provides λ. Because there is no constraint imposed on λ, both loss aversion ($\lambda > 1$) and gain seeking ($\lambda < 1$) are feasible.

APPENDIX D

EXPERIMENT FOR AMBIGUITY AVERSION

Please consider the following situation: You could choose a ball from two different urns: urn A and urn B. Urn A includes 100 balls, where some of them are white and some of them are black. However, you don't know the exact number of white and black balls. It is possible that all balls are white or black in this urn. Urn B also includes 100 balls, but you know that it consists of exactly 50 white and 50 black balls. In this case, now select a color: either white or black. Then, imagine you choose a ball from an urn. Assume you win 100 TL if the color of the ball and the color you selected has a match. If the ball has the other color, you win nothing. In this case, from which urn would you choose drawing a ball?

1. I will definitely draw a ball from urn A.
2. I may draw a ball from urn A.
3. I am indifferent between drawing a ball from either urn.
4. I may draw a ball from urn B.
5. I will definitely draw a ball from urn B.

APPENDIX E

EXPERIMENT FOR PRUDENCE

Assume that x, y, k, z_1 and z_2 are positive cash values and assume that y = x - k. I presume that there is an equal probability for the occurrence of x and y, and $+z_1$ and $-z_1$. Lottery L indicates that an individual has two options: either she can choose a zero-mean risk where she can gain or lose z_1, or she can obtain y which is by assumption lower than the initial value. Lottery R has exactly the same outline ; however, the zero-mean risk appears at the lower initial endowment state. A prudent participant would choose lottery L over lottery R whereas imprudent individual would prefer R to L . In the experiment, there are five binary choices presented to the participant in the form illustrated in Figure E.

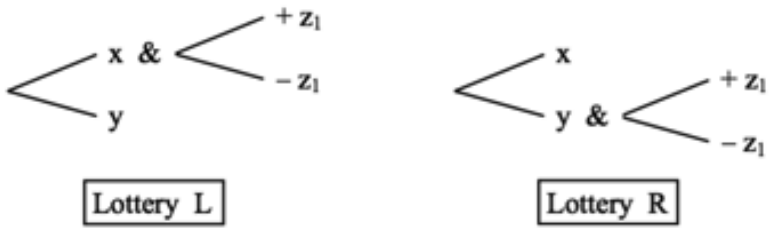

Figure E. The illustration of the game

A list of choices between lottery R and L is provided in Table E. The notation we would use in the paper is: [x - y], which means that this lottery yields y or x which has equal probability in occurrence. Thus, the lottery in the Figure E could be showed as $[(x+[\, z_1 \_ - z_1\,])\_ y]$

There are five choices for prudence. The choices are changed with respect to (i) the starting wealth level x (endowment), (ii) the decreased wealth level y which is defined as x - k by assumption, and (iii) the level of the risks z_1 and z_2.

Table E. List of Choice Situations

	Left Prospect	Right Prospect
Prud 1	[(90+[20_-20])_60]	[90_(60+[20_-20])]
Prud 2	[(90+[10_-10])_60]	[90_(60+[10_-10])]
Prud 3	[(90+[40_-40])_60]	[90_(60+[40_-40])]
Prud 4	[(135+[30_-30])_90]	[135_(90+[30_-30])]
Prud 5	[(65+[20_-20])_35]	[65_(35+[20_-20])]

There is no indifference option meaning that participants always have to choose either one of the lotteries. The level of prudence is measured with the total prudent choices that a participant makes.

APPENDIX F

CORRELATION ANALYSIS FOR LOSS AVERSION

Table F1. Risk Averse in Gain and Loss Domain

	Self-reported	Trust - banking	Trust - people	Rutgers	Crt	Amb. Aversion	Prudence	Loss aversion
Self-reported	1							
Trust - banking	0.297**	1						
Trust - people	0.197	0.299**	1					
Rutgers	0.327**	-0.297**	-0.1403	1				
Crt	-0.017	0.2109	-0.0748	-0.3094**	1			
Amb. Aversion	0.0099	-0.059	0.184	-0.1765	0.1717	1		
Prudence	0.0076	0.068	-0.109	0.0949	0.2196	0.0104	1	
Loss aversion	0.268*	-0.0103	-0.0078	0.2999**	-0.3198**	-0.143	-0.0252	1

Table F2. Risk Averse in Gain and Risk Seeking in Loss Domain

	Self-reported	Trust - banking	Trust - people	Rutgers	Crt	Amb. Aversion	Prudence	Loss aversion
Self-reported	1							
Trust - banking	0.4146***	1						
Trust - people	0.0686	0.119	1					
Rutgers	0.1891*	0.0977	-0.157	1				
Crt	0.0954	0.0255	-0.0609	0.0275	1			
Amb. Aversion	-0.0323	0.1025	-0.123	0.1584	0.0358	1		
Prudence	-0.0189	0.1526	0.0213	-0.0919	0.19*	-0.0988	1	
Loss aversion	0.0144	-0.0201	-0.2006*	0.3804***	0.0198	0.0744	-0.1626	1

Table F3. Risk Seeking in Gain and Risk Averse in Loss Domain

	Self-reported	Trust - banking	Trust - people	Rutgers	Crt	Amb. Aversion	Prudence	Loss aversion
Self-reported	1							
Trust - banking	0.6256***	1						
Trust - people	0.2952**	0.17	1					
Rutgers	0.1669	-0.1144	0.1663	1				
Crt	0.2874*	0.3075**	0.1487	-0.1778	1			
Amb. Aversion	0.0028	-0.1442	0.0982	-0.2407	0.0124	1		
Prudence	0.0281	-0.1388	0.0177	0.1663	0.0098	0.0727	1	
Loss aversion	0.0968	-0.0753	-0.1081	0.0524	-0.2657*	-0.0478	-0.1625	1

Table F4. Risk Seeking in Gain and Loss Domain

	Self-reported	Trust - banking	Trust - people	Rutgers	Crt	Amb. Aversion	Prudence	Loss aversion
Self-reported	1							
Trust - banking	0.3731***	1						
Trust - people	-0.1676	0.0424	1					
Rutgers	0.3206***	-0.0388	-0.0663	1				
Crt	0.0156	-0.0411	0.1516	0.0987	1			
Amb. Aversion	-0.1731	-0.0837	0.089	-0.0758	0.0403	1		
Prudence	0.0341	0.0293	-0.0918	-0.0421	0.2934***	-0.0062	1	
Loss aversion	0.2101*	0.0426	0.0402	0.333***	-0.1389	0.1522	-0.1238	1

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