Utility Function and Risk Taking: An Experiment

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ABSTRACT

Investing by its very nature is an emotional business. Few investors have the self-knowledge, emotional stamina or self-control to make rational, intelligent and profitable decisions, particularly in times of uncertainty. The main purpose of this study is to examine the style of financial risk taking, and in particular the psychological profiles associated with different risk taking behaviours. Behavioural economics and finance increases the explanatory power of models by providing it with more realistic psychological foundations. The assumption of behavioural risk taking leads to three fundamental approaches to risk: Risk avoiders abstain from investments they perceive to contain risk, risk reducers participate in high risk investments in spite of the risks involved, and risk optimisers who are motivated by the exposure to risk. This study identifies and characterizes individual investors based on their shared investing attitudes and behaviour. It finds out evidence of a behavioural search for investments based on a questionnaire approach suggested by LeBaron, Farrelly and Gula (1989). The approach to risk is studied by a psychometric measure, "Risk Assessment Inventory" prepared for the Turkish investors. The research data is analyzed using statistical techniques, namely frequency, percent, arithmetic mean, chi-square independent test, non-linear principle component analysis and t-test. The result of the research data have shown that there are not much significant differences between the variables related to the amount of investment when they are analyzed with respect to the dimensions of risk assessments.

INTRODUCTION

Most people view risk as a chance of loss or that some unfavourable event will occur. But in fact, risk refers to the uncertainty that surrounds future events and outcomes. When we think of an investment, risk is the chance of actually receiving less than expected. Risk is simply the variability in the returns or outcomes from the investment. Investment risk, then, is related to the possibility of actually earning a return other than expected whereas the greater the variability of the possible outcomes, the riskier the investment. The return expected from an investment is positively related to the investment's risk. But this relationship is not quite as clear-cut as it sounds, because risk can be defined in two bases: *1. stand-alone risk*, which is the risk associated with an investment when it is held by itself, not in combination with other assets, and *2. portfolio risk*, which is the risk associated with an investment when it is held in combination with other assets (Besley; Brigham, 2000, s.182).

At the same time, uncertainty is a major factor in decision-making especially the case here for investment. Uncertainty is a fact of life. People face risks every time they make an investment. But there are financial institutions that can mitigate risk. This side of the case is related with the portfolio risk where the financial intermediary plays a role in diversification (reducing risk). Beyond the existence of stated institutions and their activities in the financial system, this study is discussing the individual behaviour (risk attitudes) with respect to choices involving uncertainty (Varian, 1996, s. 212).

A behavioural finance literature review reveals five main constructs that drive investor behaviour: investment horizon, confidence, control, risk attitude, and personalization of loss (Wood ; Zaichkowsky, 2004, p. 170). Although there is a degree of risk in everything, some activities increase risk while other activities reduce it. A risky activity has two characteristics: the likely outcome and the degree of variation in all the possible outcomes. Suppose we are offered a 50 per cent chance of making $100 and a 50 per cent chance of losing $100. On average you will make no money by no money by taking such gambles. They are called fair gambles. A fair gamble is one which on average will make exactly zero monetary profit. Financial economists identify risk attitudes as of three main segments of individual investors: ***1. risk-averse*** (risk-intolerant traders) ***2. risk-neutral*** (risk-indifferent traders) ***3. risk-takers*** (confident traders). The crucial question is whether or not the individual would accept a fair gamble.

A risk-averse person will refuse a fair gamble (i.e. one which on average will make exactly zero monetary profit). This does not mean that he or she will never bet. If the odds are sufficiently favourable, the probable monetary profit will overcome the inherent dislike of risk. On the other hand, a risk neutral person is only interested in whether the odds will yield a profit *on average*. This investor pays no attention to the degree of dispersion of

possible outcomes, betting if and only if the odds on a monetary profit are favourable. A risk-lover will bet even when a strict mathematical calculation reveals that the odds are unfavourable. The more risk-loving the individual, the more unfavourable must the odds be before the individual will not bet (Begg; Fischer; Dornbusch, 2000, s. 237).

Conventional finance theory considers all investors to be rational individuals who intent on maximizing their utility. In markets where, according to Lucas (1978), all investors have "rational expectations", prices do fully reflect all available information and marginal-utility-weighted prices follow martingales. The efficient market hypothesis has been extended in many other directions, including the incorporation of non-traded assets such as human capital, state-dependent preferences, heterogeneous investors, asymmetric information, and transactions costs. But the general thrust is the same: individual investors form expectations rationally, markets aggregate information efficiently, and equilibrium prices incorporate all available information (Lo, 2004, p. 3). With rational expectations, most companies would find it virtuall impossible to persuade investors to provide funding. In particular, behavioral finance seems to offer some explanations for the observed activities. Behavioural finance combines the theory of finance with ideas from the psychology and sociology to devise more realistic facts about the way people behave when they are making financial decisions, as it is clear from recent market activity that prices do not always react efficiently (Owen, 2002, p.4). Psychological research shows that the effect of context on decision making can be powerful (see, e.g., Goldstein & Weber, 1995; Loewenstein, 2001) and some recent experimental economics studies have explored context effects too (e.g., Cooper, Kagel, Lo & Gu, 1999; Hoffman et al, 1994) (Camerer; Loewenstein, 2003, p. 8).

Decisions concerning risk mitigation generally involve tradeoffs between immediate versus delayed outcomes and certain versus risky ones (Öncüler, 2001, p. 101). Risk assessment is a complicated subject with important before-the fact as well as after-the fact implications. No one technique or instrument can magically capture all there is to know. Nor can an investment manager, at one sitting, hope to peer into a client's head and extract a risk-tolerance level (LeBaron; Farrelly; Gula, 1989, p. 19).

This paper examines the risk taking and the effect of risk on the investment. In a set of controlled experiments directed by various securities incompanies in Turkey, a risk questionnaire was distrubuted to the Turkish investors. In particular, the study focuses on two questions: *1. What is the risk profile of investors in Turkey? 2. Does the quantity of investment change the risk attitude in Turkey?*

The outline of the paper is organized as follows: After beginning with a summary of the study, Section 2 gives information about the background notion for risk taking and the theory it is dealt with. Section 3 provides the data and the methodology in detail. Section 4 discusses the empirical results, and lastly Section 5 is devoted to the conclusion of the research.

UTILITY FUNCTION AND RISK TAKING

Many theories, both financial and statistical, depend largely on how we represent and model uncertainty. Dealing with uncertainty is also of the utmost importance, reflecting individual preferences and behaviours and attitudes towards risk. Decision making under uncertainty is in fact an extensive body of approaches and knowledge that attempts to provide systematically and rationally an approach to reaching decisions in such an environment. Issues such as `rationality', `bounded rationality' etc., have an effect on the fundamental and practical problems that finance is assumed to address. In a simplistic manner, uncertainty is characterized by probabilities. Adverse consequences denote the risk for which decisions must be taken to properly balance the potential payoffs and the risks implied by decisions trades, investments, the exercise of options etc. Of course, the more ambiguous, the less structured and the more uncertain the situations, the harder it is to take such decisions. Further, the information needed to make decisions is often not readily available and consequences cannot be predicted. Risks are then hard to determine (Tapiero, 2004, p. 4).

Financial decision making seeks to make money by using a broad set of economic and theoretical concepts and techniques based on rational procedures, in a consistent manner and based on something more than intuition and personal subjective judgement. Generally, it also seeks to devise approaches that may account for departures from such rationality. Behavioural and psychological reasons, the violation of traditional assumptions regarding competition and market forces and exchange combine to alter the basic assumptions of theoretical economics and finance (Tapiero, 2004, p. 5). Economics can be distinguished from other social sciences by the belief that most

(all?) behaviour can be explained by assuming that rational agents with stable, well-defined preferences interact in markets that (eventually) clear (Rabin; Thaler, 2001, p. 219).

The first extension of this study is the utility theory. Utility theory provides a formal foundation for expressing risk-sensitive planning objectives. It is a normative theory for decision making (von Neumann and Morgenstern, 1944; Fishburn, 1970; Barberá et al., 1998). As a component of decision theory, it focuses on formal properties of preference structures. For this thesis, we adopt the version of (von Neumann and Morgenstern, 1944), also known as the von Neumann-Morgenstern utility theory. Utility theory studies preference structures and their numerical representations in form of utility functions. In this section, we introduce the preference relations and results about the existence of utility functions. We also discuss how decisions are made with the aid of utility functions. A preference structure can be formulated as a binary preference relation (Bölücüler, p. 103).

The first property of a utility function is wealth. If we want to choose between two certain investments, we always take the one with the largest outcome. The second property of a utility function is an assumption about an investor's taste for risk. There are three assumptions as stated before: risk aversion, risk neutral and risk seeking. If $U(W)$ is the utility function and $U''(W)$ is the second derivative (Gruber, 1991, p. 194). Friedman and Savage (1948) have explained the existence of utility function under choices involving risk. Each individual can be characterized by a utility function to every level of wealth and acts in the face of known odds so as to maximize expected utility (Markowitz, 1952, p.151). In any uncertain investment, the individuals maximize $E\ U(W)$; the expected value of their utility function (Gruber, p. 195). Expected utility theory has dominated the analysis of decision making under risk. It has been generally accepted as a normative model of rational choice and widely applied as a descriptive model of economic behaviour (Kahneman; Tversky, 1979, p. 263). Individuals can have different risk attitudes, that is, different ways of evaluating a gamble. Risk attitudes are modeled using the individuals' utility functions. Based on the utility functions, types of risk attitudes: (Heitger, 2004, pp. 8-9 ;Van Aarde, 2001, p. 13).

1.If you chose not to play the game you are risk averse, then $U(W) > E[U(W)]$ such that $U''(W) < 0$.
2.If you are risk neutral, then $U(W) = E[U(W)]$, such that $U''(W) = 0$.
3.If you are risk seeking then $U(W) < E[U(W)]$ such that $U''(W) > 0$.

$U\,E[W]$ = utility of expected wealth
$E\,U(W)$ = expected utility of wealth

Functions that exhibit the property of greater change in value for larger unit changes in the argument are functions with positive second derivatives. Thus the acceptance of a fair game implies a positive second derivative. These conditions are summarized in Table 1 (Gruber, p. 196).

Table 1: Acceptance Of A Fair Gamble

Condition	Definition	Implication
1. Risk aversion	Reject fair gamble	$U''(0) < 0$
2. Risk neutrality	Indifferent to fair gamble	$U''(0) = 0$
3. Risk preference	Select a fair gamble	$U''(0) > 0$

Source: Gruber, p. 197

The curvature of the expected utility function describes the individual's attitudes toward risk. If it is concave, the individual is a risk averse and if it is convex, the individual is a risk lover. Risk aversion and risk seekingness defined above are global properties of risk attitudes, since these properties do not change with the wealth level (Varian, p. 221). A risk-neutral utility function is linear, and thus is equivalent to an identity function; a utility function is risk-sensitive if and only if it is not risk-neutral, that is, if and only if it is nonlinear. An individual who is neither a risk preferer nor a risk-averter is called risk-neutral (Friedman, 1986, p. 305).

On the other hand, prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992) has probably had more impact than any other behavioural theory on economic research. Prospect theory is very influential despite the fact that it is still viewed by much of the economics profession at large as of far less importance than expected utility theory. Among economists, prospect theory has a distinct, though still prominent, second place to expected utility theory for most research (Shiller, 1997, p. 3). The fundemantel of the prospect theory is the Kahneman and Tversky (1979) value function. The value function differs from the utility function in expected utility theory in a very critical respect: the function (of wealth or payout) has a kink in it at a point, the

"reference point," the location of which is determined by the subjective impressions of the individual. The reference point is the individual's point of comparison, the "status quo" against which alternative scenarios are contrasted. Taking value as a function of wealth, the Kahneman-Tversky value function is upward sloping everywhere, but with an abrupt decline in slope at the reference point (today's wealth or whatever measure of wealth that is psychologically important to the subject). For wealth levels above the reference point, the value function is concave downward, just as are conventional utility functions. At the reference point, the value function may be regarded, from the fact that its slope changes abruptly there, as infinitely concave downward. For wealth levels below the reference point, Kahneman and Tversky (1979, 1981, 1986, 1990) found evidence that the value function is concave upward, not downward. People are risk lovers for losses, they asserted (Shiller, 1997, p. 5).

Indeed, these studies find that uncertain losses are generally preferred to certain ones of the same expected magnitude, implying risk-seeking behaviour when losses are concerned. That is, when risk of loss is present, people are observed to embrace, capitalize on, benefit from, or exploit this risk of loss, because according to these empirical results, it is preferred to a certain loss of the same expected size. Thus, the conventional explanation for the demand for insurance--a preference for certainty or a desire to avoid the risk of losses--flies in the face of empirical evidence (Nyman, 2001, p. 2).

In finance, standard equilibrium models of asset pricing assume that investors only care about asset risks if they affect marginal utility of consumption, and they incorporate publicly available information to forecast stock returns as accurately as possible (the "efficient markets hypothesis"). While these hypotheses do make some accurate predictions--e.g., the autocorrelation of price changes is close to zero--there are numerous anomalies. The anomalies have inspired the development of "behavioural finance" theories exploring the hypothesis that some investors in assets have limited rationality. Important articles are collected in Thaler (1993) and reviewed in Shleifer (2000) and Barberis and Thaler (2001).

An important anomaly in finance is the "equity premium puzzle": Average returns to stocks are much higher than returns to bonds (presumably to compensate stockholders for higher perceived risks) (Camerer, Lowenstein, p. 41). Benartzi and Thaler (1995) assume a combination of decision isolation--investors evaluate returns using a 1-year horizon--and aversion to losses. These two ingredients create much more perceived risk to holding stocks than would be predicted by expected utility (Shiller, p. 7). Barberis, Huang and Santos (2001) use a similar intuition in a standard asset pricing equation. Several recent papers (e.g., Barberis, Shleifer & Vishny, 1998) show how empirical patterns of short-term underreaction to earnings surprises, and long-term overreaction, can arise from a quasi-Bayesian model. Another anomaly is the magnitude of volume in the market. The so-called "Groucho Marx" theorem states that people should not want to trade with people who would want to trade with them, but the volume of stock market transactions is staggering. Odean (1999) presents data on individual trading behaviour which suggests that the extremely high volume may be driven, in part, by overconfidence on the part of investors (Camerer, Lowenstein, p. 42).

The rise of behavioural finance is particularly striking because, until recently, financial theory bet all its chips on the belief that investors are too rational to ignore observed historical patterns-- the "efficient markets hypothesis." Early heretics like Shiller (1981), who argued empirically that stock price swings are too volatile to reflect only news, and DeBondt and Thaler (1985), who discovered an important overreaction effect based on the psychology of representativeness, had their statistical work "audited" with special scrutiny (or worse, were simply ignored). In 1978 Jensen called the efficient markets hypothesis "the most well-established regularity in social science." Shortly after Jensen's grand pronouncement, however, the list of anomalies began to grow (Camerer, Lowenstein, p. 43).

DATA AND METHODOLOGY

Two hundred individual investors were surveyed via questionnaire. Respondents are asked for their attitudes on risk only, neglecting the demographic items. The questionnaire has 10 items that consist of 3 choices addressing risk attitudes. All questions ask for attitude towards risk in general, allowing respondents to indicate their willingness to take risks, with indicating complete unwillingness to take risks, and indicating complete willingness to take risks. As we feared of a disagreement of respondents with the assessment assured by the questionnaire we limited the questions of the survey. There is a general belief that questionnaires take to long and the subjects are not eager to respond or discuss their views. Therefore, we neglected the potential demographic questions of the survey:

Risk Questionnaire

Please answer the following items by selecting just one of the three available alternatives: a) always b) never c) sometimes

1. Betting on unique ideas
2. Capitalizing on opportunities
3. Careful buying
4. Conservative management
5. Diversification techniques
6. Fear of losses
7. Fear of random events
8. High-stake choices
9. Not following the crowd
10. Stable returns

A cluster segmentation analysis identified three main segments of individual investors: 1. risk-averse; 2. risk-neutral and 3. risk-takers. Each segment purchased different types of stocks, used different information sources, and had different levels of trading behaviour. The research data is analyzed using statistical techniques, namely frequency, percent, arithmetic mean, chi-square independent test, non-linear principle component analysis and t-test.

Risk attitude is usually measured by psychometric approaches, such as scales and questionnaires. Psychometric approaches directly attempt to measure risk attitude by asking respondents to indicate how much they agree with a set of statements. Both approaches implicitly assume that individual risk attitude is a stable personality trait. Previous empirical studies have primarily focussed on relating risk attitude to individual decision making, e.g. entrepreneurial decisions (Brockhaus 1980), acquisitions (Pablo et al. 1996) and asset allocation (Riley and Chow 1992) (Fellner; Maciejovsky, 2002, p. 1). Some psychologists and economists however, have questioned whether stable utility functions and risk preferences exist at all, given that risk attitudes appear to be highly malleable with respect to context in laboratory experiments (e.g., Slovic, 1964, 1972a and 1972b; Eckel and Grossman, forthcoming). An alternative interpretation of this evidence (Weber et al., 2002), of course, is that a stable risk preference does exist, but that individuals believe the typical risk in one context is greater than in another, and indicate different willingness to take risks accordingly (Dohmen et al., 2005, p. 4).

The traditional theory of decision making under uncertainty, integrating statistics and the risk behaviour of decision makers has evolved in several phases starting in the early nineteenth century. At its beginning, it was concerned with collecting data to provide a foundation for experimentation and sampling theory. These were the times when surveys and counting populations of all sorts began. Subsequently, statisticians such as Karl Pearson and R. A. Fisher studied and set up the foundations of statistical data analysis, consisting of the assessment of the reliability and the accuracy of data which, to this day, seeks to represent large quantities of information (as given explicitly in data) in an aggregated and summarized fashion, such as probability distributions and moments (mean, variance etc.) and states how accurate they are. Today, decision making is economics, finance, insurance and risk motivated (Tapiero, p. 6).

EMPIRICAL RESULTS

As we limited the questionnaire neglecting the demographic items, the response to the risk survey was quite positive.

Table 2: Chi-Square Results

Risk Questionnaire	Chi-Square	p
Betting on unique ideas	**6,023***	**0,049**
Capitalizing on opportunities	1,942	0,379
Careful buying	1,269	0,530
Conservative management	2,235	0,327
Diversification techniques	1,680	0,432
Fear of losses	0,077	0,962
Fear of random events	3,805	0,149
High-stake choices	0,848	0,654
Not following the crowd	4,425	0,109
Stable returns	0,311	0,856

*: ($p < 0.05$)

Table 3: Crosstab Count

Investors Choices		Betting on unique ideas			Total
		always	never	sometimes	
Amount Of Investment	HIGH	65(%42)	34(%22)	55(%36)	154
	LOW	19 (%42)	17(%37)	9 (%21)	45
Total Investors		84	51	64	199

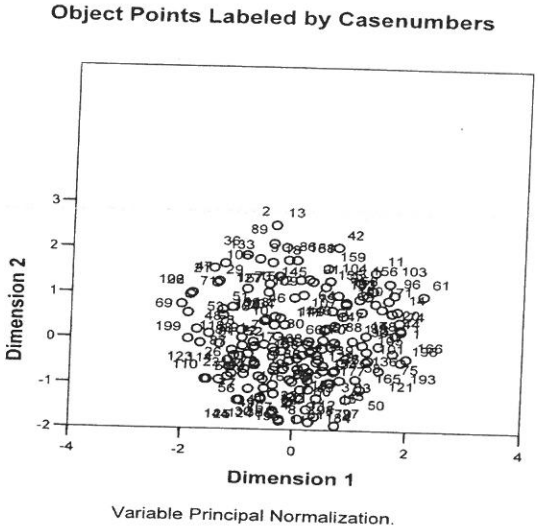

Figure 1

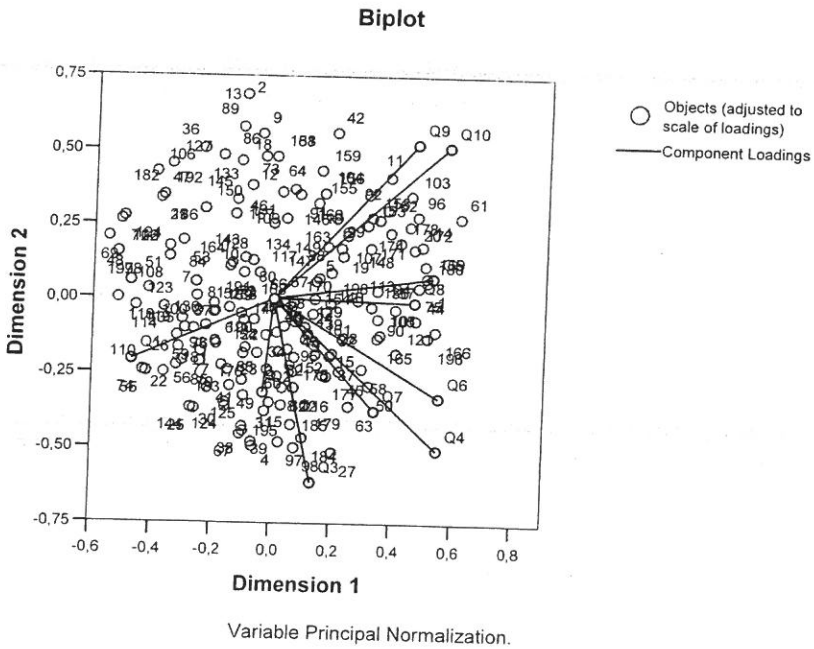

Figure 2

As shown in Table 2, low scale and high scale investors do vary only in question 1. In Table 3 the crosstab count results of this question were given. That means, low scale investors abstain from betting on unique ideas

rather than high scale investors do. Within the rest of the nine questions, low scale and high scale investors do not differantiate as they have no significant statistical diversity. On the other hand, to judge the concordance and the placement of the investors to one another, Nonlinear Principle Component Analysis was applied. According to the results of the analysis, there are two dimensional interpretation out of it. At first dimension, the value of Cronbach alpha is 0,862; at the second one, the value is 0,814; and in total the value is 0,938. As these values are close to 1, each reliability of dimension has the appropriate values. The eigen value of the first dimension is 6,005 and of the second is 4,686. According to these values, at the first dimension the % 60 of variance and at the second one the % 40 of variance is applicable. At both dimensions respondent investors' replies are shown in Figure 1. The result here reflects that there is no different grouping between low scale and high scale investors. The biplots of the replies given to the questionnaire have been added to the figure and this projection is shown in Figure 2. According to Figure 2, as of the replies given, the investors placement to one another is shown.

Investors that attended the questionnaire had been grouped as "risk taking" and "risk averse". The 10 questions of the risk questionnaire therefore, being categorized as "risky responds" and "not risky responds" address the level of taking risk of the investors. As a result, if an investor responds the 10 questions completely as risk averse then he wili get 10 points; otherwise will get 20 points. The points between 10-20 show the risk level of investors. In our study, minimum risk level has found as 10 and maximum as 17 points. The mean of the risk level is 12,874 and the standard error of mean is 0.13. This result found as a low level of risk point shows that the investors are risk-averse. According to the risk measure that varies between 10-20, the risk value pointing to a value lower than 15 shows that the investors can be risk averse. This has been tested by t - test. As a result, $t=-16.323$ ($p=0.000$). The result shows that statistically at %1 significance level the investors' responds are below the value of 15 ($p<0.01$). Therefore, the investors can be identified as risk averse according to this study. At the same time, as seen from the histogram, the distribution of risk points (of investors) is mostly located at the low risk level.

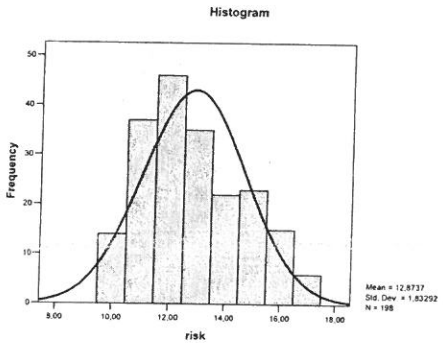

Figure 3: Histogram For Risk Points Of Investors

CONCLUSION

The behavioural theories have much latitude for interpretation, when they are combined with observations and experiments about behaviour in financial markets, they allow us to develop theories that do have some restrictive implications. Financial researchers has taken heed of the lessons of the behavioural research surveyed here. Doing research that is sensitive to lessons from behavioural research does not mean entirely abandoning research in the conventional expected utility framework. The expected utility framework can be a workhorse for some sensible research, if it is used appropriately. It can also be a starting point, a point of comparison from which to frame other theories. It is critically important for research to maintain an appropriate perspective about human behaviour and an awareness of its complexity.

The decision about how much risk to take is extremely a pschological one. A risk questionnaire or survey can help to provide investors with a more accurate vision of decision making process. It may also provides an inventory of some demographic database. Moreover, a risk survey of investors can show the risk tolerances of them. An awareness and understanding of the current risk tolerances of investors is a key ingredient in establishing the risk profile in the markets. Understanding the current state of risk tolerance of investors will assist in developing a risk profile and making decisions on what risks must be managed, how, and to what extent. It will also help identify the challenges associated with risk consultations and communication. In general, there is lower risk tolerance for the

unknown, where impacts are new, unobservable or delayed. There are higher risk tolerances where people feel more in control. Risk tolerance can be determined through consultation with affected parties, or by assessing investors' response or reaction to varying levels of risk exposure. Risk tolerances may change over time as new information and outcomes become available, as societal expectations evolve. Before developing management strategies, a common approach to the assessment of risk tolerance needs to be understood.

Here, the risk survey of Turkish investors shows that their general attitude is risk-aversion. So the first question of our study has been derived from the results of the statistical analysis that addresses the risk profile as risk- aversion. A noticeable result of our experiment is the observation that, in this risk survey, the behaviour of a large number of investors appear to be consistent with expected utility theory and risk-aversion preferences. They all know that investment in Turkey is risky. It is clear that Turkish investors feel that the financial markets in Turkey have a great deal of volatility causing risk and therefore the investment horizon does vary with regard to the macroeconomic imbalance that affects the stability and efficiency in markets. At the same time, the risk profiles do not differ between high scale and low scale investors in Turkey. The second focus of the study show that there is no significant evidence statistically providing the scale of investment with risk attitude.

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