

Lucian Blaga University of Sibiu
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SUMMARY OF DOCTORAL DISSERTATION

**THE INTERACTION OF
SUBJECTIVITY AND OBJECTIVITY
IN THE PROCESS OF RISKY
INVESTMENT DECISION MAKING**

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2013

Contents

List of Tables 4

List of Figures 5

List of Appendices 7

List of Publications 8

Introduction 9

PART I. – THE PRESENT STATE OF RESEARCH 16

Chapter 1 – Investment Risks and Quantitative Methods of Risk Evaluation 17

1.1. The Approach of Risks of Investment in Economic Theory 17

 1.1.1. Investment Decisions in Economic Theory 17

 1.1.2. Investments and Risk Theory 21

 1.1.3. Types of Risks 27

 1.1.4. Decisions under Risk and Risk Perception 32

 1.1.5. Investment Risk and Insurance 36

1.2. Quantitative Methods of Risk Evaluation 37

 1.2.1. Risk Evaluation 37

 1.2.2. Types of Risk Measurements, Indicators, and Quantitative Methods of Risk
Analysis 39

 1.2.3. Measuring Risk Perception 46

Chapter 2 – Contemporary Research of Subjective Factors in Economic Behaviour 53

2.1. Behavioural Economics and Decision Making 53

 2.1.1. Biases in Judgements 59

 2.1.2. Preferences in Decision Making 61

2.2. The Role of Emotions in Decision Making 66

 2.2.1. Emotions and their Importance in Decision Making 70

 2.2.2. Visceral Factors in Decision Making 76

2.3. Decision Making under Risk and Uncertainty 78

 2.3.1. Prospect Theory 83

PART II. – ORIGINAL CONTRIBUTIONS	92
Chapter 3 – A Proposed Model for Illustrating the Interaction of Subjectivity and Objectivity in Investment Decision Making	93
3.1. Evidences from Neuroeconomics of the Existence, Role and Necessity of Emotions in Economic Decision Making	94
3.2. Economic Decision Making Models Capturing the Effect of Subjectivity and of Emotions	108
3.2.1. Prospect Theory	108
3.2.2. A Model of the Effect of Affect in Economic Decision Making	112
3.2.3. A Model of Projection Bias	113
3.3. Proposed Model for the Mechanism of the Psychologically Influenced Decision Making Process	115
Chapter 4 – Experiment for Testing the Role of Subjectivity in the Investment Decision Making Process	140
4.1. Experimental Economics – Theoretical Background	141
4.1.1. Short History of Experimental Economics	141
4.1.2. Economic Experiments – An Overview	143
4.1.3. Experimental Economics and Experimental Psychology – Similarities and Differences	147
4.1.4. Experimental Design and Experimental Methods in Behavioural Economics	149
4.1.5. Individual Decision Making Experiments and Experiments under Uncertainty and Risk	162
4.2. The Experiment	167
4.2.1. Experimental Design and Methods for Testing the Effect of Mood on Investment Decision Making	167
4.2.2. Mood Induction Procedure – Evaluation and Results	176
4.2.3. Decision Making Tasks – Evaluation and Results	178
4.2.4. Applicability of the Experimental Findings and Results	195
Conclusions and Recommendations	205
Bibliography	210
Appendices	218

Introduction

Key words: behavioural economics, experimental economics, decision making, risk, investment, subjectivity, objectivity

The relevance and topicality of the thesis:

Over the last few decades, contemporary economics started to pay special attention to the achievements of other sciences, such as psychology, neuroscience, sociology etc., including them in economic researches. Classical economics was more connected to psychology, but the neo-classical economics turned away from psychology, rationalizing the behaviour of economic agents, which led to involuntary and unpredictable errors. One of the basic economic processes is decision-making. From the traditional economic perspective only the economic and objective factors of decision-making were considered and examined. Neo-classical economists have been examining economic factors from different perspectives, while they kept adding new economic factors. Although, they knew that not only objective factors were decisive, they only examined those. Researchers of neo-classical economics did not pay much attention to psychological factors in decision making.

Decision making is influenced by many different parameters and factors. Interestingly, economic decisions are made similarly to common emotional decisions. The continuous examination of more and more economic factors does not advance the deeper understanding of decision-making, because the psychological factors are just as important.

Contemporary economics deals with many exciting topics today. Since economic agents are humans, it is absolutely necessary to also pay attention to, and examine the cognitive, emotional and subjective factors at work in decision making. In the last few decades a new field of economics was born, known as behavioural economics, and its related field: behavioural finance. Behavioural finance seeks to explain the set of psychological biases which affect investment decision making. Behavioural researches are combining psychological insights with traditional economics theory and models. Behavioural research of decision making is a continuously growing field.

Psychological factors, such as subjectivity, emotions, mood and intuition influence the investment decision making process. These influences and effects are studied and investigated by behavioural economics and behavioural finance. However, when it comes to investments, human psychology and emotional influences play a crucial role in decision making. Even though the idea that emotional influences are involved in decision making suggests negative consequences,

current research shows that emotions and human psychology are an important and strong component of the decision making process and they are sometimes even necessary for making good decisions.

The research on decision making was exponentially growing during the last three decades, and presently, more and more studies are being conducted on this matter. The problem of modelling decision making involving psychological factors continues to be a key-problem in behavioural economics. The necessary to incorporate common sense psychology into economic models is a difficult challenge for economic researchers, challenges which seem to be addressed successfully. The problem of handling biases in judgements, intuition, emotional effects and other psychological factors in economic theory and economic modelling is still at the top of behaviour economists' research interests.

A few decades ago, economic researchers started to further develop their techniques and methodologies by involving research methods and tools from other sciences interested in researching economic decision making, such as neuroscience and experimental psychology. These steps led to the birth of two subfields of economics, which are: neuroeconomics and experimental economics. These two subfields provide, among others, findings and research results to economists on the matter of psychological influences on decision making. Neuroeconomics studies brain activities, using neuroscientific techniques, related to economic behaviour, such as: economic and investment decision making under risk. Experimental economics contributes to the observation and study of psychological processes in economic behaviour in a controlled environment searching for more relevant conclusions.

Besides the theoretical research of decision making, behavioural economists are very much interested in empirical evidences supported by experimental findings and results. The process to integrate psychological factors in economics opened new perspectives to researchers. An increasing set of methods and tools help experimental economists to design and conduct behavioural experiments, providing evidences of the role of subjectivity and psychology in the decision making processes.

The objective of the dissertation:

The above mentioned issues and facts are one of the newest interests of current economics, which presently keep behavioural economists busy. The main objective of this dissertation is the argumentation and reasoning for the role and importance of subjectivity and the role of psychological factors, such as: emotions and intuition, in the investment decision making process under risk and uncertainty. It was approached, in particular, the interaction of

subjectivity and objectivity in investment decision making and the effects of different moods on investment decisions under risk and on risk perception.

Achieving the objective of the research involved the following steps:

- Systematization of theoretical approaches to the investment decisions and to the investment risks;
- Analyzing investment risks and measurements of risks;
- Analyzing the role of psychological biases, subjectivity and emotions in economic and investment decision making
- Synthesizing the works of contemporary researchers on decision making in behavioural economics, neuroeconomics and experimental economics;
- Finding a modelling solution for the consideration of both subjective and objective factors in investment decisions;
- Researching and illustrating the role of the subjective factors in decision;

The goals of the dissertation:

One of the goals of the dissertation is to refine our current understanding of the effects of subjective factors in decision making, particularly in the context of investments and risks. Another important goal is to produce a mathematical model of the interaction of subjectivity and objectivity in the investment decision making process. A further goal of the dissertation is to investigate through an economic laboratory experimentation the effects of different emotions and moods on risky investment decisions.

To achieve the goals of the dissertation it is necessary to:

- Identify notions and concepts of behaviour economics related to decision making and risk;
- Identify the roles and characteristics of subjective factors in investment decision making;
- Investigate decision making models involving the effect of subjectivity and emotions;
- Produce a mathematical model of the interaction of subjectivity and objectivity in the investment decision making process;
- Explore and identify the methodologies, methods and tools of experimental economics;
- Prepare, design and run an economic laboratory experiment to provide data to investigate the effects of moods on investment decisions and risk perception.

Significance of the study:

In accordance with the objective and the goals of the dissertation mentioned above, this research is expected to contribute to the development of theoretical and empirical study of decision making in behavioural economics. In addition, it is hoped that this dissertation will generate further interest in the researching of the psychological components of investment decision making.

Synopsis of the dissertation:

The dissertation is structured according to its objectives and goals. It consists of four chapters, each covering the core content of the research.

The first Chapter – Investment Risks and Quantitative Methods of Risk Evaluation – reviews the literature on investment risks in economic theory.

Subchapter 1.1 – The Approach of Risks of Investment in Economic Theory – presents the concept of investment decision in the economic theory focusing on the investment risk factors and its types. The research continues with the analysis of investment decisions under risk, including the concept of risk perception.

Subchapter 1.2 – Quantitative Methods of Risk Evaluation – presents the quantitative methods of risk evaluation and risk analysis. Also identifies and presents the types of risk measurements and indicators used in investment risk analysis according to the contemporary economic literature. It further presents the measurement tools for measuring risk perception.

The second Chapter – Contemporary Research of Subjective Factors in Economic Behaviour – consist of a literature review on the behavioural economics approach of psychological effects in decision making in general, and the role of emotions in decision making in particular.

Subchapter 2.1 – Behavioural Economics and Decision Making – presents the birth of the field of behavioural economics and its approach to decision making. Rabin (1998) says that the study of human behaviour has to be integrated into economics, and the tractable and parsimonious psychological findings should not be avoided by the economic research.

According to Kahneman (2003), economists often criticize the psychological researches because of their biases and errors, but the economical rational agent models are psychologically

unrealistic. Psychology can explain phenomena with integrative concepts, which cannot be explained by economics. According to Kahneman (2003), two types of cognitive processes are involved in the decision making process. The two types of cognitive processes of intuition and reasoning are labelled as System 1 and System 2. Decision making, judgments and choices are normally intuitive and people usually do not think with effort, so System 2 is lightly monitoring the judgements. Sometimes, however, System 2 notices some errors in System 1's intuitive judgement, and then makes an effort to correct it. System 2 is positively correlated with intelligence, cognition and statistical thinking; and it can suffer errors because of time pressures, good mood etc.

This subchapter covers the identification and analysis of biases in judgements and preferences in decision making, including social preferences, intertemporal preferences, reference levels and framing effects:

- People make their decisions based on certain reference level and not on the general situation. The following reference level effects are discussed in this subchapter: endowment effect, status quo bias, diminishing sensitivity, reference points.
- People are not totally self-interested and pure profit maximisers rather they have social preferences, thus important social characteristics are present in their economic behaviour. These social characteristics are: equity, fairness, status seeking, simple and reciprocal altruism etc.
- Decision makers' preferences are affected by inconsequential variations in the description of outcomes, known as framing effect.
- Changes in people's preferences are time sensitive and they are captured by intertemporal choice models. The basic intertemporal choice model is the discounted utility model with a fix discount rate, which was later developed into hyperbolic time discounting models involving short-run and long-run discount factors.

Subchapter 2.2 – The Role of Emotions in Decision Making – focuses on the role of emotions in decision making, addresses the emotions and their importance, and the presence of visceral factors in decision making. People make economic decisions not only based on their preferences, but also based on their perception of possible outcomes and on the probability of possible occurrences, employing a decision making process, which involves cognition and calculations. Decision makers' perception is influenced by emotions, which can be immediate emotions and expected emotions. The consequentialist models of decision making are capturing the decision makers' perception of probable outcomes. Earlier, economist were mostly interested in expected emotions such as regret, guilt and disappointment, but later they started researching

the effect of immediate and incidental emotions on decision making, which might propel decision making into a different direction.

Emotions are present in the economic and investment decision making process. According to research findings from behavioural economics, emotions might have also positive and negative effect on decision making. There is a strong relation between cognition and emotions, which are strongly involved in the decision maker's reasoning and evaluation.

Subchapter 2.3 – Decision Making under Risk and Uncertainty – presents decision making under risk and uncertainty, and discusses the Prospect theory. Investment decisions usually involve risk and uncertainty. Decision making under risk and uncertainty is not only a cognitive activity, because people react to risk on two separate levels: on a cognitive evaluation level and on an emotional reaction level. Risk perception and risk attitudes are related to emotions. One of the most famous alternative models of decision making under risk is the Prospect theory of Kahneman and Tversky (1979). They demonstrated that many psychological factors are present and involved in risky decision making, and that people are loss averse rather than risk averse when losses are present among the possible outcomes.

The third Chapter – A Proposed Model for Illustrating the Interaction of Subjectivity and Objectivity in Investment Decision Making – is dedicated to the theoretical illustration of the importance and role of subjectivity and emotions in the decision making process. This chapter presents the contemporary neuroeconomics evidences about the existence, necessity, importance and influence of emotions in the economic decision making process. There are discussed some decision making models in the field of behavioural economics, which suggests the idea that both, the psychological and the cognitive systems have a role in the decision making process.

Subchapter 3.1 – Evidences from Neuroeconomics of the Existence, Role and Necessity of Emotions in Economic Decision Making – discusses the research findings of neuroeconomics considering the role and necessity of emotions in decision making. Neuroscientists pointed out that the deliberative and cognitive system related processes are located in the brain's frontal areas, while the automatic and affective behaviour related processes unravel in the limbic reward areas. According to Sanfey et al. (2009), the most common dichotomy in the decision making theory is the emotional and the cognitive systems. The responsible part of the brain for emotions, such as fear, anger and happiness, is the amygdala. In this area of the brain negative and positive stimuli make the amygdala neurons very active, resulting in signals which may drive automatically the behaviour. Other systems, which are involved in the decision making process

are the automatic, intuitive system; the controlled, explicit, evaluative system; the deliberative action-selection system; and the habit action-selection system etc.

Subchapter 3.2 – Economic Decision Making Models Capturing the Effect of Subjectivity and Emotions – presents a few behavioural economic decision making models, capturing the effect of subjectivity and emotions in economic decision making, such as: a model of the effect of affect in economic decision making, a model of projection bias and the Prospect theory.

The prospect theory suggests that people are not aware of the computations the brain makes during editing and evaluating prospects. People make their decisions according to how they process and understand information and not based on the utility of a certain option. Kahneman and Tversky (1979) specify the value function, which has the following properties: the utilities are evaluated in terms of gains and losses relative to a reference point; the value function is concave for gains and is convex for losses; it is steeper for losses than for gains; and the proposed S shape of the value function is steepest at the reference point. (See Figure 1)

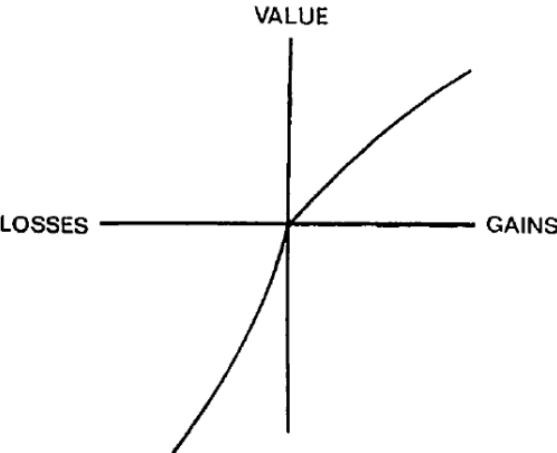


Figure 1 – Kahneman and Tversky’s (1979) proposed hypothetical value function – Source: Kahneman and Tversky (1979)

Subchapter 3.3 – Proposed Model for the Mechanism of the Psychologically Influenced Decision Making Process – presents the proposed model created for the mechanism of the psychologically influenced decision making process, capturing the interaction of subjectivity and objectivity. It needs to be emphasized that investment decisions are made based on several factors and because of this the decision making process is complex and complicated, as it is based on a large range of externally observable and mostly unobservable decision determinants. Also one needs to consider that the decision making process is influenced by subjective psychological factors and subconscious intuitive thinking.

In the professional literature the goal of most behavioural economics researches and models is the study of the influence of one of the concrete emotions and feelings, such as regret, optimism, pessimism, anger, joy etc. My research focuses, not on the effects of one specific emotion, but on the collective influence of the totality of all present emotions in the process of investment decision making. My analysis does not address the ambiguity whether the investor wants or does not want to invest. It addresses the decision making process from the moment when the notion of the desire to invest has emerged and it faces all known and unknown possible psychological and economical factors.

Since the desire to invest already exists, depending on whether the objective informations suggest that the investment should or should not be done, the subjective perception of the informations and the emotional, psychological factors may interfere and suggest the opposite. In other words the investor may decide contrary to what the objective informations indicate. It is this particular segment of the investment decision making process that I express in a corresponding mathematical formula.

The decision making process involves all observable and unobservable decision determinants. The proposed model can show how the decision maker makes his decision and what the decision should be based on the observable decision determinants. The model allows a more pragmatic understanding of the decision making process, thus moving the theory closer to how investment decision making takes place in reality.

The model can also provide answers concerning the interaction and functionality of the two systems proposed by Kahneman (2003). He explains the existence of the intuitive System 1 and the cognitive System 2 in the decision making process, and also their role and importance in decision making. According to my research of the field, Kahneman or other researchers, have not propose yet a model simulating this interaction of the two Systems, which explain the mechanism of the functionality of System 1 and System 2 in the decision making process. The model explains the interaction between Kahneman's intuitive System 1 and cognitive System 2, as these systems can be seen as the Subjective partial decision for System 1 and the Objective partial decision for System 2.

The fourth Chapter – Experiment for Testing the Role of Subjectivity in the Investment Decision Making Process – besides introducing the field of experimental economics and its methodologies, presents my economic laboratory experiment and its findings and results. There is much research done in experimental economics on the effect of emotions in the decision making process. Usually the effect of a specific emotion, such as anger, regret, guilt etc., is studied, not only theoretically but also empirically. In reality, however, in the decision making

process a whole mixture of emotions are involved, producing a general state, which affects the mood of the individual. For obvious reasons, besides understanding the effect of particular emotions on decision making, there is a need to study the overall effect of moods on the investment decision making process. The economic laboratory experiment presented in this chapter is testing the effects of different moods on investment decision making, risk perception and risk attitude.

Subchapter 4.1 – Experimental Economics – Theoretical Background – presents an overview of the birth and history of experimental economics, which is followed by a comparative analysis of experimental economics and its related field, the experimental psychology. This subchapter identifies and discusses experimental designs, methods and tools used in behavioural economic laboratory experiments. It ends with the presentation of individual decision making experiments under risk and uncertainty.

In *Subchapter 4.2 – The Experiment* – is presented my experiment in three steps: the experimental design, the mood induction procedure including its evaluation and results, and the decision making tasks including their evaluation and results.

In this experiment I am testing the effect of induced positive (happy) mood and the effect of induced negative (sad) mood on investment decisions and risk aversion. I am analysing the effect of positive and negative mood on the decision whether the subject is willing to invest or not, but also the effect of positive and negative mood on the size of the invested amount in a risky asset. I am testing whether the different moods have different effects on individuals' risk aversion, using the Holt-Laury risk aversion measurement. According to my findings based on the experimental data, there is evidence that mood affects decisions and risk perception, therefore there is further need for their study and research.

Design:

There are two treatment groups with happy and sad mood induction and a control group with neutral mood. One group's behaviour is compared with the other groups' behaviour, which is a between subjects design.

Participants:

A request for running the experiment with an ethical statement was lodged and accepted. The experiment was conducted at Bolyai Farkas Theoretical High School in Targu Mures, Romania (a total of 166 students). The participants are high school students, young people who

are about to become independent and soon start making important investment decisions for their future. Since the participants are all about 18 years old, the history effect was under control. The participants have not experienced yet mortgage, they have not made any real investment decisions yet, therefore their past experiences cannot influence their behaviour.

Procedure:

It was used the 'independent groups design'. All the sessions were run manually. In total six sessions were run, two sessions for each of the three groups. The three groups were divided in two treatment groups and a control group. The first treatment group (TP) was induced in a positive, happy mood, and the second treatment group (TN) was induced in a negative, sad mood. The control group (C) had maintained their neutral mood, and a neutral mood induction procedure was used. All three groups performed the same mood induction method, only with different emotion valences. The questionnaires contain hypothetical questions about investment decision making.

Experiment program:

The first part of the experiment session was the mood induction procedure, where participants had to fill out a mood induction questionnaire specific for their group (positive, neutral and negative) to induce the desired mood, while a mood congruent music was played in the background, for each group, while participants were filling out the first questionnaire. After participants completed the mood induction procedure, which took about 7-8 minutes, their mood change was measured by Visual Analogue Scale (VAS).

In the second part of the experiment participants had to make decisions. It was handed to each subject a second questionnaire with decision tasks, which was exactly the same for all participants and for all groups.

The timeline of the experiment can be followed on Figure 2.

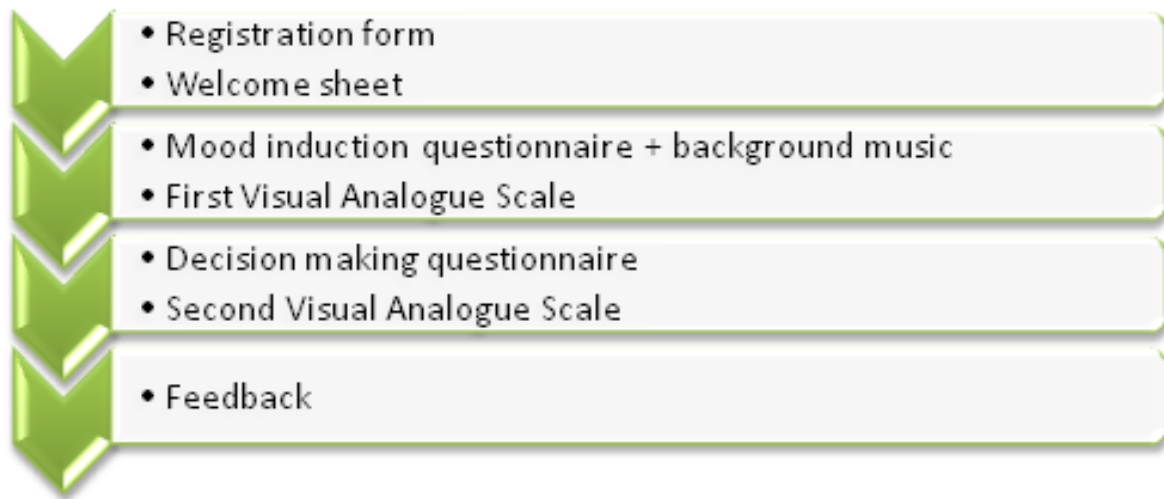


Figure 2 – The timeline of the experiment – Source: Developed by the author

Mood induction procedure – evaluation and results

For the Positive (happy) mood induction procedure a writing task was used, where participants had to write about a very happy moment in their lives, and about another very funny experience. W. A. Mozart’s Clarinet Concerto in A, Opus 107 was played during the first part of the experiment to induce a positive, happy mood in participants.

For the Negative (sad) mood induction procedure the same type of writing task was used, where participants were instructed to imagine the death of someone they loved, and specific instructions were given what details to focus on. During this part of the experiment ‘Adagio for Strings, Op. 11’ by Samuel Barber was played.

For the Neutral mood induction procedure for the Control group (C) the same type of writing task was used as in the two treatment groups, except for the valence of the induced mood. Participants were instructed to imagine a usual day when they have to go for grocery shopping and write about what they are buying and what they notice in the grocery shop. During this time Kraftwerk’s ‘Pocket Calculator’ was played.

Mood assessment:

All participants were tested for mood change. Participant’s mood ratings were recorded on Visual Analogue Scale (VAS) after both, the mood induction questionnaire and the decision making questionnaire to see the mood level change over the duration of the experiment. The VAS consisted of a 10 cm line and all VAS mood ratings were measured in millimetres from the reference point on a scale of -50 to 50, where 0 is the reference point.

There was no difference between male and female students in average responses to the mood induction procedure. This means that the mood induction had the same effect on both, men and women.

See Figure 3 for the effect of the mood induction procedures for all the three groups.

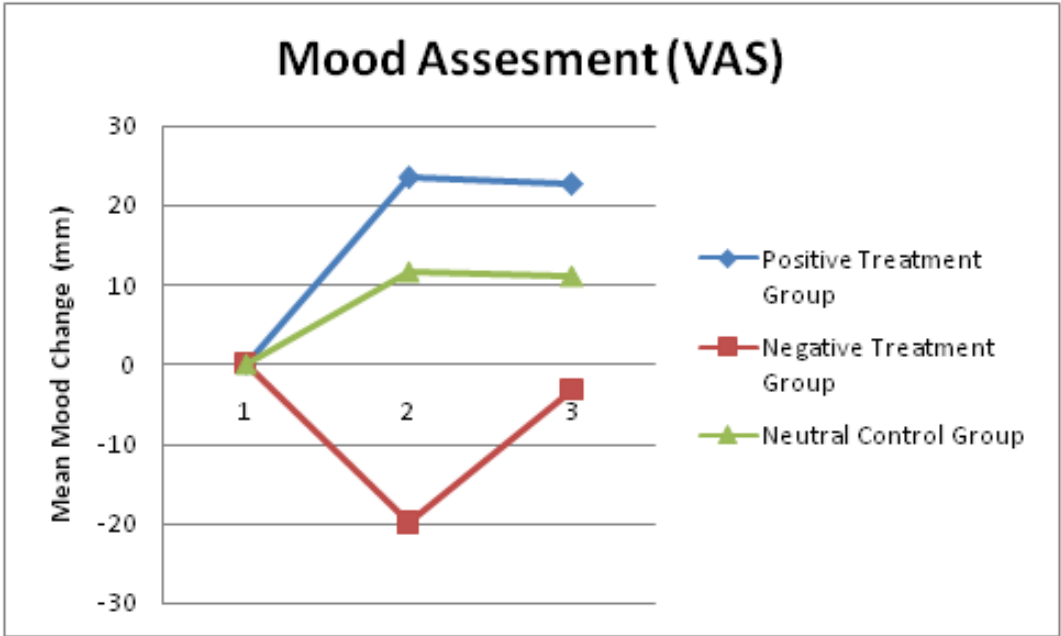


Figure 3 - Average mood change ratings throughout the experiment, measured in millimetre deviations from incoming mood on a Visual Analogue Scale (VAS); 1 – Incoming mood, 2 – Mood at the end of mood induction procedure and 3 – Mood at the end of the experiment – Source: Created by the author based on experimental data

Decision making tasks – evaluation and results

The first investment question is about investing in a car, which was designed to be a risky investment, paid off with a 5 year mortgage. The second investment question is a monetary investment designed to be very similar in risks and values to the fix investment. Participants had to answer with “YES” or “NO” to the two investment questions, depending whether they are willing to invest or not. The two investment questions are designed in 2 (Invest vs. Not invest) x 3 (mood: happy, sad, neutral) dimensions.

According to the Chi Square Test of Independence for the fix investment question there is a statistically significant difference between the three groups (with sad mood induction, with happy mood induction and control group in neutral mood) on how they decided. There is a relationship between the effect of mood and participants’ fix investment decision, because the Calculated $\chi^2 >$ Theoretical χ^2 ($5.913 > 4.61$) for the predetermined alpha level of significance $\alpha=0.10$ and 2 degrees of freedom. Both, subjects in sad mood and subjects in good mood were more willing to make a fix investment, than subject in neutral mood.

According to the Chi Square Test of Independence for the fix investment question shows that there is a statistically significant difference between the TP group and the C group, there is a relationship between the effect of positive mood induction and the fix investment decision. Significantly more people were willing to invest in a car from the TP group than from the C group. For the TP group and the C group the Calculated $\chi^2 >$ Theoretical χ^2 ($4.481 > 3.84$) for the predetermined alpha level of significance $\alpha=0.05$ and 1 degree of freedom.

According to the Chi Square Test of Independence for the fix investment question shows that there is a statistically significant difference between the TN group and the C group, there is a relationship between the effect of negative mood induction and the fix investment decision. For the TN group and the C group the Calculated $\chi^2 >$ Theoretical χ^2 ($4.058 > 3.84$) for the predetermined alpha level of significance $\alpha=0.05$ and 1 degree of freedom. Significantly more people were willing to invest in a car from the TN group than from the C group.

The main conclusion drawn from these results is that the nature (sad or happy) of the induced emotions had no different effect on subjects' fix investment decision, but the valence of the emotions (not neutral) had a significant positive effect on the willingness to invest in a car. An explanation of the fact that both groups, in positive and negative mood, were more willing to invest in a car than the group in the neutral mood, is that those who were in an induced positive, happy mood perceived the described fix investment situation more optimistically, and those who were in an induced negative, sad mood paid less attention to the risk factors.

According to the Chi Square Test of Independence for the monetary investment question shows that there is not a statistically significant difference between the three groups' answers.

The fix investment question and the monetary investment question are designed to be very similar. The biggest difference being that in one question the subject has to decide for a fix investment and in the other question the subject has to decide for a monetary investment. The results show that there were differences in the responses to the fix investment question and monetary investment question. Subjects in positive and negative mood were more willing to make fix investments than monetary investments.

Table 1 – The fix and monetary investment decisions in percentage across groups – Source: created by the author based on experimental data

	TP Group		TN Group		Control Group	
	YES	NO	YES	NO	YES	NO
Fix investment	67.857%	32.143%	67.308%	32.692%	48.276%	51.724%
Monetary investment	60.714%	39.286%	59.615%	40.385%	58.621%	41.379%
Fix investment YES from which monetary investment	57.895%	42.105%	54.286%	45.714%	60.714%	39.286%
Fix investment NO from which monetary investment	66.667%	33.333%	70.588%	29.412%	56.667%	43.333%

According to Table 1, about 40% of participants answered differently to the fix investment question and the monetary investment question, which result suggests that participants do not perceive in the same way the fix investments and the monetary investments, contrary to what the literature suggest.

Holt-Laury risk aversion measurement:

I am measuring subjects' risk attitudes. I use the Holt-Laury risk aversion measurement, by doubling the hypothetical payoffs. My research experiment took place in April 2013 in Romania, and the Holt and Laury (2002) paper was published in December 2002. The payoffs to be relevant in April 2013 in Romania, they had to be changed according to the inflation rate in Romania of the period December 2002 to March 2013. According to the National Institute of Statistics of Romania, the cumulative inflation rate in Romania in the period of December 2002 and March 2013 is 100.41 %, which is why the payoffs had to be doubled in this experiment.

Figure 4 displays the proportion of safe choices (option A) for each of the ten decisions. The horizontal axis is the decision number and the line with x-s shows the prediction for risk neutrality, where the probability that the safe option A is chosen is 1 for 4 decisions, and then this probability is 0 for the remaining 6 decisions. All participants filled out the table with the ten decisions, except 3 of 58 students in the C group did not respond to this question, therefore the remaining 55 responses were used in this analysis. Not all the subjects chose the safe option when the probability of the higher payoff was small, and then crossed over to the risky option without ever going back to the safe one. 62 subjects from 163 switched back from the risky option to the safe option. Comparing this experiment's results with the Holt-Laury low real payoffs experiment results, we can see that subjects from the Holt and Laury (2002) experiment with low real payoffs are slightly more risk averse than subjects in my experiment with hypothetical payoffs. This difference shows that subjects facing hypothetical choices cannot

perfectly imagine how they would actually behave in a real situation, although this difference is small. Subjects underestimate the extent to which they would avoid risk, as also Holt and Laury (2002) concluded in their paper.

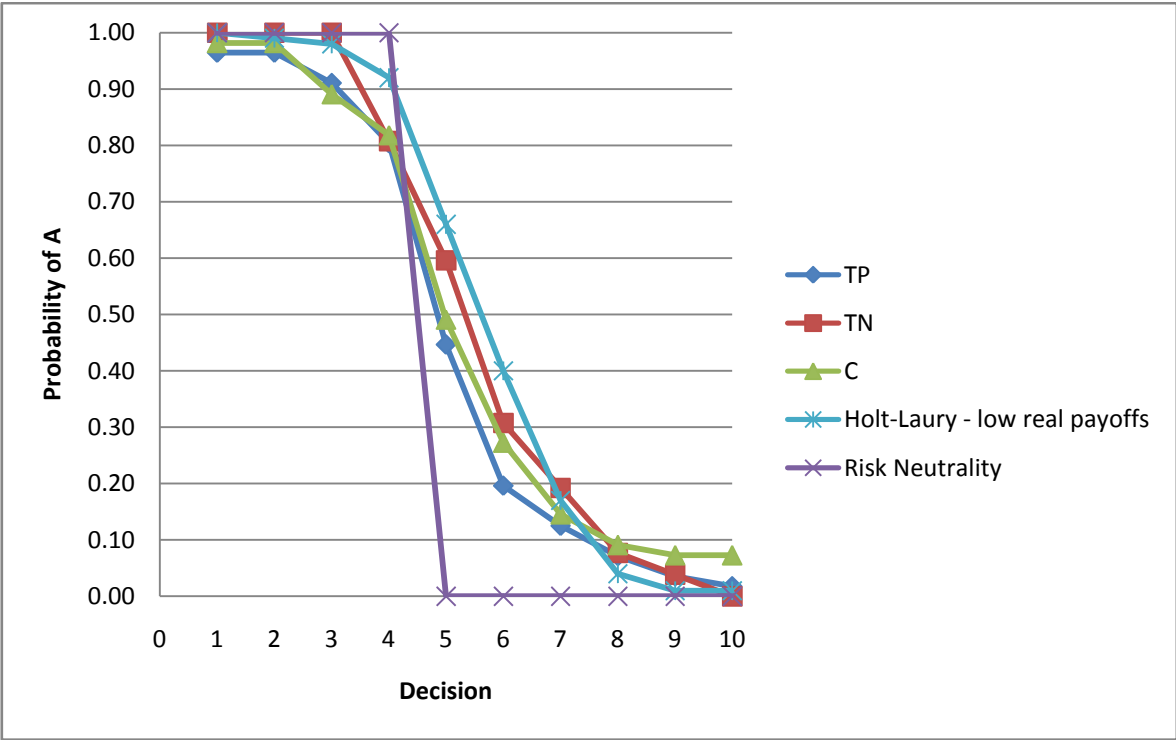


Figure 4 - Proportion of safe choices in each decision: data averages and prediction – Source: Created by the author

The Charness-Gneezy portfolio choice – Investment decisions:

This investment question was developed based on the experiment presented by Charness and Gneezy (2010). Rewarding participants, it is studied how portfolio choice (how much to invest in risky asset) depends on three mood states, positive (happy), negative (sad) and neutral. It is also studied the difference in investment behaviour for a smaller amount and a higher amount. Of course, the null hypothesis is that investment is the same in each group. The success of the investment in this task is decided by the rolling of a six sided die. To let participants choose the winning numbers gives the illusion of control. The investor chooses also who will roll the die and the number of units to invest in the risky asset for the small amount and for the large amount. All groups have the same task, but they are under a different induced mood. Performance based incentives are used at this question, in order to make it a real deal and to get real answers and not hypothetical answer.

See Figure 5, Figure 6 and Figure 7 for the group changes in the proportional invested amounts from small amount to large amount for the TN group, the TP group and the C group.

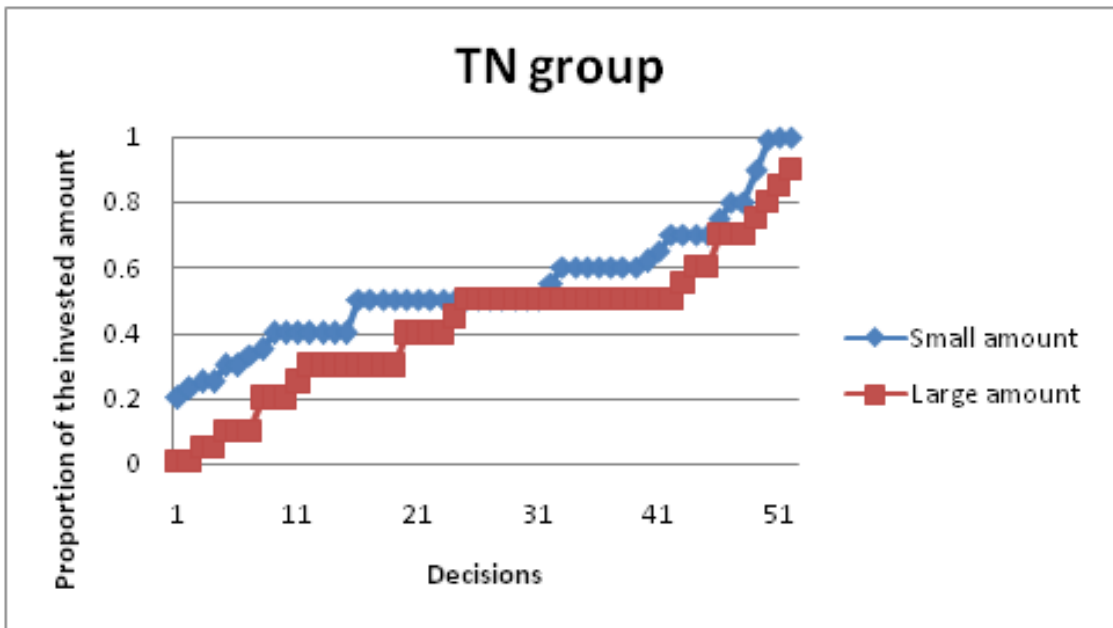


Figure 5 - The changes in the proportion of the invested sum in the TN group, from small amount to large amount – Source: created by the author

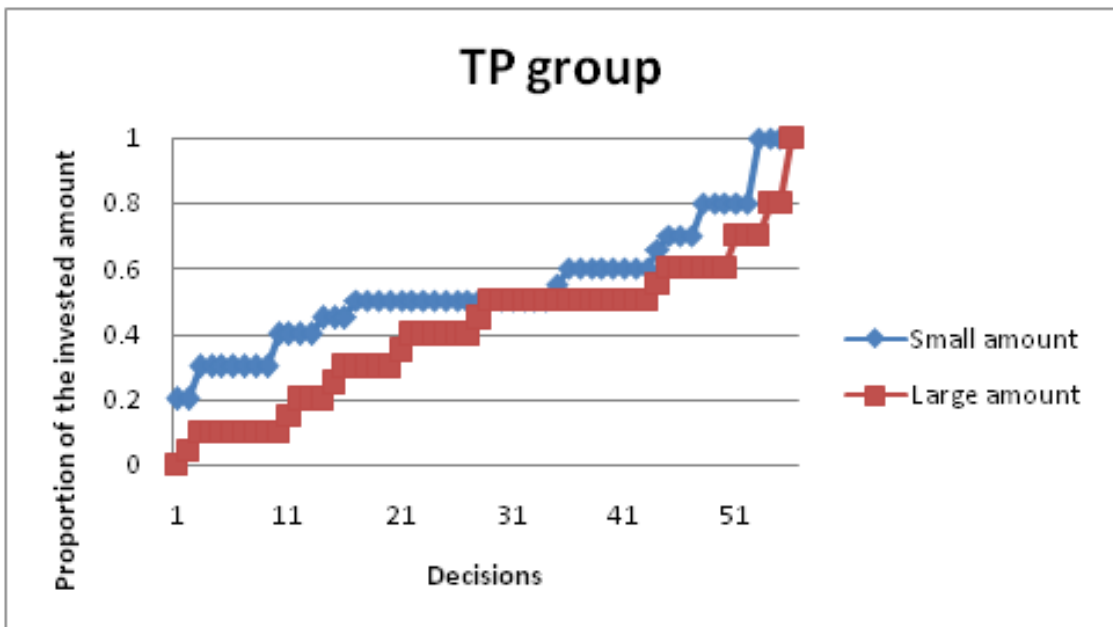


Figure 6 - The changes in the proportion of the invested sum in the TP group, from small amount to large amount – Source: created by the author

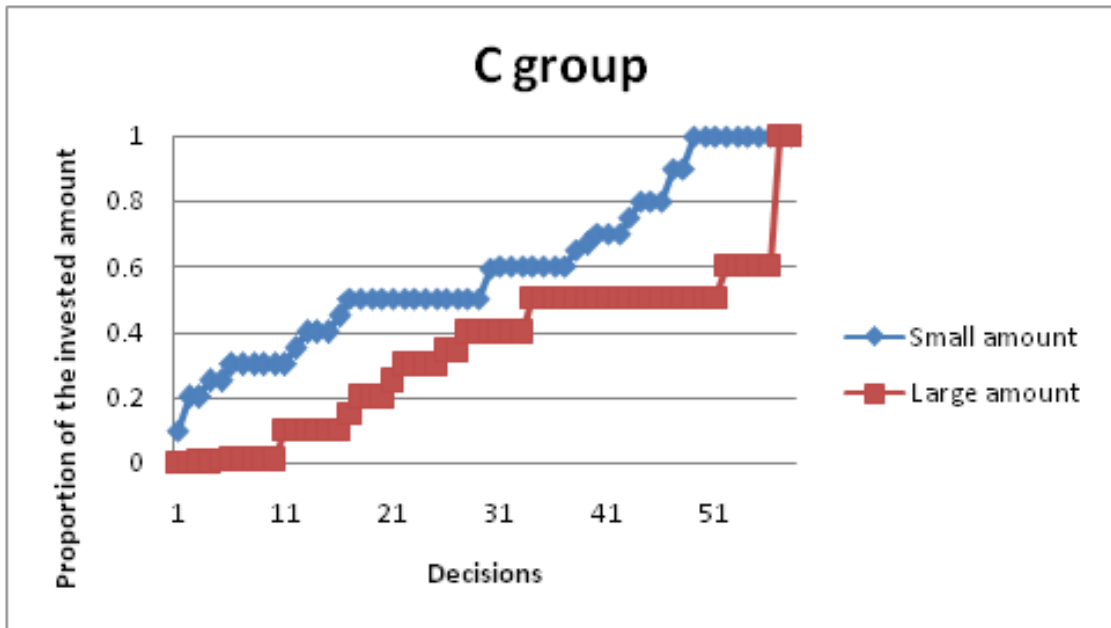


Figure 7 - The changes in the proportion of the invested sum in the C group, from small amount to large amount – Source: created by the author

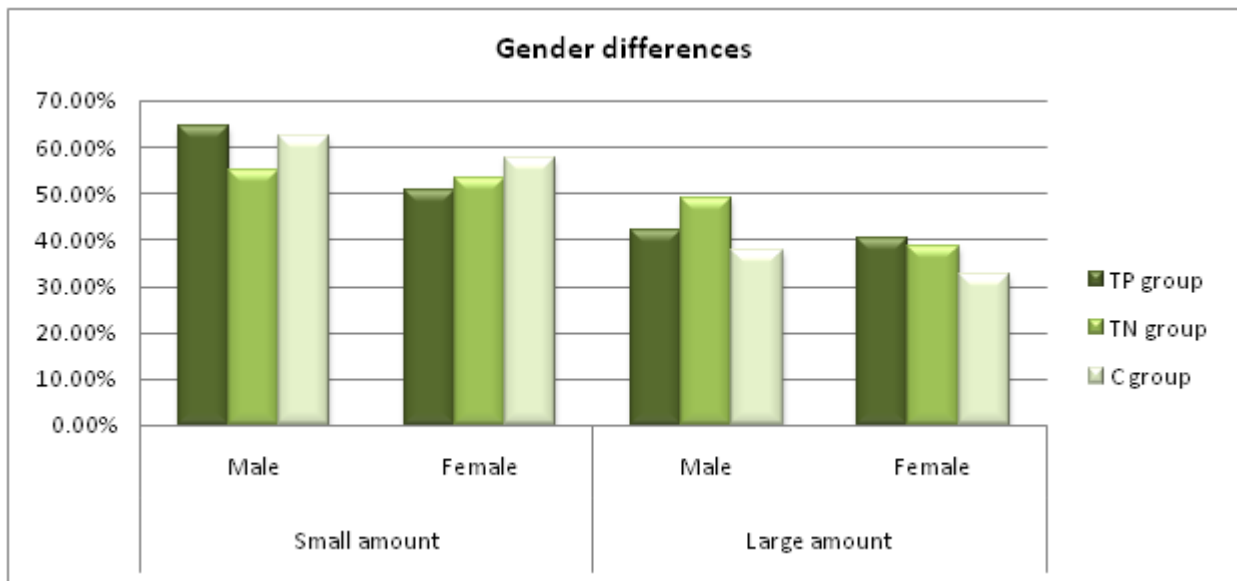


Figure 8 – Average investments in percentages. – Source: created by the author

As the Figure 8 shows, there are gender differences in investment behaviour for both the small amount and large amount, and this gender difference is observable in all three groups. On average, males invest 60.62% and females invest 53.80% from the small amount, but there is no significant difference between the males' mean investment and the females' mean investment ($t = 1.96$, $p = 0.051$). On average, males invest 42.45% and females invest 37.28% from the large amount, but there is no significant difference between the genders' investments ($t = 1.4$, $p = 0.16$).

Preference for control:

5 students from each class were chosen to actually play the investment game for presents proportional to their scores. To decide whether the investment is successful or not, a six sided die was rolled. Participants had to choose between the experimenter rolling the die or themselves rolling the die (perceived as their preference for control).

68.32% (64.81% from the TP group, 67.31% from the TN group and 72.73% from the C group) of 161 participants (5 students did not answer) chose to roll the die, which is preference for control, if they were to be chosen in as one of the 5 students per class. (See Figure 9)

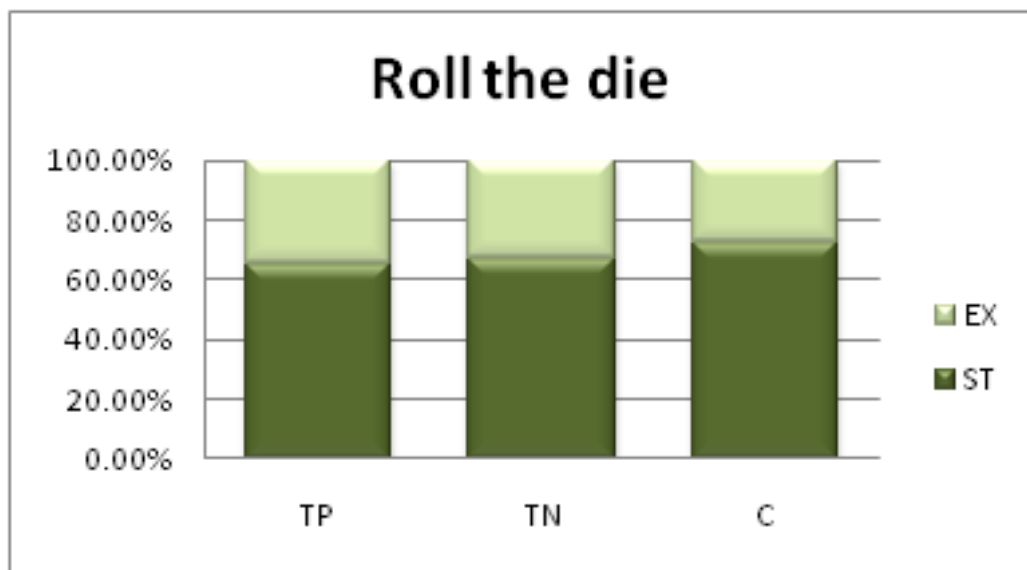


Figure 9 – Participants’ decision who to roll the die – More than two thirds of participants had preference for control – Source: created by the author

Subjective perception of probability:

Participants had to choose their three winning numbers before rolling the die. The question they were asked was if they felt that the chances to win was better if themselves pick the winning numbers or it was irrelevant who or what decided the winning numbers.

44.85% (53.57% from TP group, 46.15% from TN group and 35.09% from C group) of 165 participants (1 student did not answer) claimed that they felt their chances were better if they chose the winning numbers versus having the numbers randomly generated. This result proves the existence of subjective probability, because subjects were aware that the objective probability to get one of three numbers by rolling a six sided die is 0.5, but still almost half of the subjects thought they had a better chance if they chose their winning numbers. (See Figure 10)

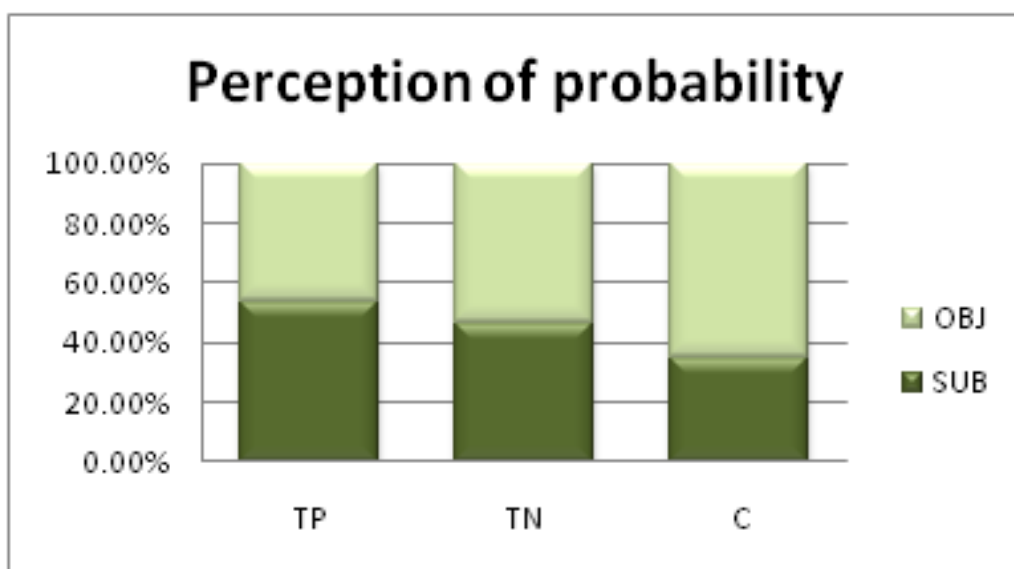


Figure 10 – Participants’ perception of probability – Source: created by the author

Research methods used in the dissertation:

For the scientific examination of the issues and for achieving the objectives and goals imposed in this dissertation, the following **research methods** were used:

- *The analytical method* was employed to conduct an analysis of the theoretical approaches to investment decisions, investment risks, psychological and subjective factors and their role in the decision making process;
- *Qualitative and quantitative research method*: qualitative research, through which the subjective and psychological factors and their effects and roles were analysed; and quantitative research through which the effects of moods on investment decision making was examined within a decision making laboratory experiment;
- *Induction method*, used in the construction of my model when reasoning from particular to general and from facts to scientific generalization;
- *Deduction method*, used in the evaluation of experimental data when reasoning from general to particular;
- *Descriptive method*, employed for the description and structuring of the subjective and psychological factors and their effects and roles in the decision making process;
- *Synthesis method*, through which links were established between the subjective factors and decisions and risk perceptions, analysed in the dissertation.

The research presents the following aspects with **innovative character**:

- Systematization and synthesis of approaches of investment decision making under risk and of risk analysis methods and measurements;
- Systematization and synthesis of the involved psychological factors in the decision making process and decision making models, based on behavioural economic, neuroeconomic and experimental economic researches;
- Systematization and comparative synthesis of experimental research methods;
- A mathematical decision making model for the interaction of subjectivity and objectivity in investment decision making was created;
- A behavioural economic laboratory experiment was designed and run for testing the effect of mood on investment decision making and risk perception;
- A series of evidences have been identified and extracted from recent economic theories and practices concerning the importance and role of emotions in decision making.

Conclusions and Recommendations

As stated in the introduction, the aim of the dissertation was to explore the role of psychological factors, such as mood, emotions and subjectivity in the investment decision making process. In this section of the dissertation I review and summarize the dissertation research, identify the main methods used and discuss their implications.

1. My research findings have indicated that there are different approaches to understand and analyse investment decisions and its risks. For the economic development of a country, investments are important and necessary. There are institutional investments and individual investments as well, which both might be fix investments (such as buildings, machineries) and monetary investments (such as stocks, bonds). One of the biggest components of an investment is its risks, which is a multi-faceted factor. Investment risks include the following: the probability distribution of the uncertain returns; the variability of the expected future returns; the possible losses and their probabilities and sizes; sensitivity to new information arrivals etc. Investors' decision making is based on investment analysis and risk analysis.

2. The economic literature identifies investment related risk types, such as the market risk, credit risk and liquidity risk. Market risks are systematic risks, related to losses

which can be controlled, shared or hedged. Credit risks of investments are time-dependent and dynamic. Liquidity risks depend on the investments' cash-flow structure.

3. According to my research of evaluation of investments under risk and risk analysis, the literature provides a rich set of measurements, tools, methods and indicators, such as: risk premium, net present value, volatility, expected value, expected loss ratio, sensitivity analysis, and many others.

4. When investors make investment decisions they make those decisions based on their subjective perception of their investment analysis and their risk analysis results. Risk perception and risk tolerance are influenced by many external, psychological and social factors. Depending on their risk perception there are three types of agents: the risk seeker, the risk neutral and the risk averse.

5. The fact that investment decisions are partially subjective, influenced by psychological factors, during the last decades, researchers have been more and more interested in investigating this subjective part of decision making. Based on my research findings many social and even biological sciences are increasingly interested in researching the decision making process.

6. My research has confirmed that investment decision making under risk has important psychological components, such as: beliefs, biases in judgements, overconfidence, optimism, representativeness, conservatism, anchoring, availability bias and others. In addition to psychological factors, decision makers also have preference characteristics, which may lead to different decisions than predicted by the traditional economic theory:

- Economic and investment decisions are often made based on some reference levels, rather than on the general situation;
- People have social preferences when they make financial decisions, and they are not fully self-interested and they do not act only as profit-maximisers;
- People change their preferences depending on the inconsequential variation of the outcome descriptions, which is known in the literature as the framing effect;
- Preferences are time-sensitive, which are captured in intertemporal choice models.

7. Also, research findings suggest that emotions, subjectivity and other psychological factors have important roles and effects on the decision making. Investment decision makers' behaviour, their perception of possible outcomes, probabilities and their decision making process are influenced by their emotions. The role and importance of emotions is researched, among others, by behavioural economists, psychologists and neuroeconomists. Emotions may be immediate emotions and expected emotions, but only the latter was research until a few years ago. Economists were mostly interested in the effect of regret, disappointment,

guilt, but there are current researches on the effect of immediate emotions on the decision making process as well.

8. Emotions play an important role on the risk perception of economic agents. Investment decisions are based on the decision maker's reasoning and evaluation, which involves both, cognition and emotions. The decision maker's risk analysis happens on two levels: on a cognitive evaluation level and on an emotional reaction level. The role of emotions and subjectivity in the decision making process is researched empirically and theoretically as well.

9. A recently emerged subfield of economics, which is much interested in the study of the role of emotions in decision making under risk, is neuroeconomics. Neuroeconomics studies economics related issues by employing techniques and methods of neuroscience. Research results from neuroeconomics make the role of emotions in decision making even more unquestionable. It provides findings concerning the importance and necessity of emotions in economic decision making, emotions, which sometimes may even help economic agents to make better decisions.

10. Based on my observations of the field, there are more and more economic models, developed by economic and behavioural economic researchers, which capture the effects of psychological components. These models in general concentrate on one specific emotion, or one specific type of emotional reaction, or subjective behaviour. I developed a theoretical decision making model, which captures the role and the influence of subjectivity (including emotions, mood, intuitions etc.) in the investment decision making process.

11. The proposed model captures the interaction of subjectivity (including existing and immediate emotions, mood, intuition, unconscious reaction, and unobservable determinants) and objectivity (including the conscious cognitive evaluation, analysis, calculations, and observable determinants) in an investment decision through a proposed mechanism. One of the objectives of my proposed model is to capture the overall effect of all subjective and psychological components on the investment decision making. The model permits to simulate decision making for all types of decision makers. (By type I mean to what extent the decision makers base their decision on the subjective components.)

12. My model can also provide answers concerning the interaction and functionality of the two systems proposed by Kahneman (2003). He explains the existence of the intuitive System 1 and the cognitive System 2 in the decision making process, and also their role and importance in decision making. According to my research of the field, Kahneman or other researchers, have not propose yet a model simulating this interaction of the two Systems, which explain the mechanism of the functionality of System 1 and System 2 in the decision making

process. My model explains the interaction between Kahneman's intuitive System 1 and cognitive System 2, as they can be seen as the Subjective partial decision for System 1 and the Objective partial decision for System 2.

13. Besides the theoretical approaches of investment decision making, the literature provides empirical researches as well. A recently developed subfield of economics, which provides experimental data to research empirically decision making, is experimental economics. Laboratory experiments in behavioural economics are used to analyse human behaviour in economic settings under a controlled environment in order to clearly identify causality. Experiments can provide data to researchers, when such data cannot be found in natural settings.

14. According to my comparative study and analysis of experimental economics and experimental psychology, the following designs and methods are used in behavioural experiments:

- Scientific research can be: qualitative research, which uses general and broad research questions collecting descriptive data, and quantitative research, which uses specific and narrow hypothesis collecting measurable data;
- Experimental designs can be: within-subjects design, where each individual is exposed to more than one treatment, and between-subjects design, where each individual is exposed to only one treatment;
- Economists and psychologists have different opinions about the use of incentives, deception, context, selecting subjects and repetition in laboratory experiments;
- Mood induction procedures in behavioural economics laboratory experiments are developed by psychologists, such as: descriptive writing task involving a vividly imagined situation; and musical mood induction procedures involving the listening of mood congruent music.

15. Besides the proposed theoretical model, based on my research of experimental methods and decision making experiments, I prepared, designed and ran an individual decision making experiment. The aim of the experiment was to analyse the effect of emotions and mood on investment decision making and risk perception. The first goal of the experiment was to test the effect of the mood induction procedures (positive, negative and neutral), for which I used the Visual Analogue Scale, a tool for mood assessment. The second goal was to see how participants in different induced moods make risky investment decisions and whether the induced moods influenced their decisions and risk preferences. The main experiment design was a between-subjects design, where participants were randomly assigned to two treatment groups (with positive, happy induced mood and with negative, sad induced mood) and to a control group (with neutral induced mood).

16. Based on my findings and results of the experimental data, the following conclusions can be drawn:

- The selected mood induction procedures were effective, and the subjects in the experiment entered the desired moods.
- The responses to fix investments and monetary investments with similar values and risks differed, suggesting that context matters in subjects' responses.
- Both, the happy and sad mood significantly influenced subjects' fix investment decisions in a positive direction compared to the decisions of subjects in neutral mood. Positive and negative mood did not influence participants' decisions differently, which means that what mattered was the valence of the mood, meaning that participants were not in a neutral mood. This finding suggests that participants in neutral induced mood were more loss averse and risk averse than subjects from the two treatment groups.
- According to the Holt-Laury risk aversion measurement, the experimental findings show that subjects in negative mood were more risk averse than subjects from the other groups.
- According to the Charness-Gneezy portfolio choice decision task, which I extended to larger hypothetical amount too, I found that people invest significantly less in proportion from a larger amount than from a smaller amount. This suggests that loss aversion and risk aversion increases with the increase of the invested amount. Subjects' behaviour in neutral mood suggests higher loss aversion than subjects' behaviour in positive and negative induced moods.
- The experiment's results provide evidence for the existence of subjective probabilities and also provide evidence for the fact that people have a preference for control.
- Based on the results of the experiment, one can see that mood and emotions may influence investment decision making under risk and may also influence the risk perception. According to participants' statements, about 80% of the subjects claimed that they consulted their intuitions, feelings and emotions when they made their decisions. This finding suggests that emotions and mood influence decision making, not only unobserved by the decision maker, but most people consciously consult their feelings and intuitions.

17. The results of the experiment show that mood does affect investment decision making. This suggests that mood might influence people when they make their decisions for real investments and with real money. The magnitude of the influence might differ in real life from

the influence observed in the experiment, where hypothetical questions were used. It can be concluded, however, that mood influence exists and should be considered when investment decision making is researched.

18. The results of the experiment can be applied to further behavioural economic research. For instance banks and corporations could use such information to better understand how their clients make their investment decisions. They can analyze the effect and the influence of emotions and mood on people's investment decision-making. They can use the analysis and its results for preparing and promoting investment and credit offers. More advantageous strategies could be worked out by paying attention to people's feelings and moods when they make their decisions. It is also true that the experiment results could be useful to the individual investors. If people know that their moods and feelings influence their investment decisions and that these influences play an important role in the decision making process, they can pay attention to this fact when they consider investment and credit offers, and when they make their actual investment decisions.

19. Decision making, as part of behavioural economics, is a newly researched field. In my dissertation I point out that much work has been done in this area. According to my research the role and effect of psychological factors in investment decision making under risk is a recently investigated field, relying on the methodologies of new subfields of economics, such as behavioural economics, neuroeconomics and experimental economics. Still a lot more is needed to be done in this field.

20. My research on investment decision making under risk presented in this dissertation, contributes to the existing literature theoretically and empirically. My proposed theoretical model is able to fill a small gap in the existing literature, by incorporating the effects of multiple and mixed psychological factors on decision making, which modelling, according to my research, has not yet been done. The model contributes to a better and a more realistic understanding of investment decision making, capturing the interaction of subjectivity and objectivity. The proposed model can land itself for further investigation and development.

21. The presented experiment and its results contribute to the economic literature in the sense that, apparently there have been no experiments conducted with the same design as mine. This experiment provided useful results and findings, but it would be interesting to repeat it with a larger sample size and also with other target groups.

22. To be able to develop and improve economic models and the economic theory, it is necessary and important to research further and understand better human behaviour under the influence of psychological and subjective factors on investment decision making, risk aversion and other economic issues.

List of publications:

1. Virlics, Ágnes (2011) The Rosia Montana Mining Project – A Business-Psychology Presentation, International Conference on Business and Management, Social Sciences Research Society (SoSReS), Izmir, Turkey, *International Journal of Business and Management Studies*, Vol. 3, No. 1, pp. 21-30, ISSN: 1309-8047 (Online)
2. Virlics, Ágnes (2011) Psychological Effects of the Financial Crisis, 18th International Economic Conference, Sibiu, Romania, *Revista Economica*, No. 2 (55), pp. 642-647, ISSN 1582-6260
3. Virlics, Ágnes (2011) Psihologia Economică. Abordarea Psihologică și Economică a Comportamentului Economic, Conferinta Stiintifico-practica Internationala a Tinerilor Cercetatori cu genericul “Dezvoltarea economiei bazate pe cunoastere” Editia a II-a, *Institutul International de Management “IMI-NOVA”*, Chisinau, Republica Moldova, ISBN: 978-9975-4215-0-8
4. Virlics, Ágnes (2012) Risk Perception in Investment Decision Making, The International Conference in Economics and Administration, Bucharest, Romania, *Faculty of Business and Administration, University of Bucharest*, pp. 607-617, ISSN: 2284–9580 ISSN-L: 2284–9580
5. Virlics, Ágnes (2013) Emotions in Economic Decision Making: A Multidisciplinary Approach, Lumen International Conference Logos Universality Mentality Education Novelty (LUMEN), Iasi, forthcoming in *Procedia – Social Behavioral Sciences, Elsevier*, accepted for publication
6. Virlics, Ágnes (2013) Investment Decision Making and Risk, 20th International Economic Conference, Sibiu, forthcoming in *Procedia – Economics and Finance, Elsevier*, accepted for publication
7. Virlics, Ágnes (2013) Emotions and Decision Making, The International Conference on Economics and Administration, Bucharest, Romania