Manipulating Individuals' Risk-Taking with Financial Incentives: A Myopic Loss Aversion Experiment

Finance

Master's thesis

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2009

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Approved by the Council of the Department ____ / ____ 20____ and awarded the grade____

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HELSINKI SCHOOL OF ECONOMICS (HSE) **SUMMARY**
Finance, Master's Thesis 19.11.2009
Vladimir Abramov

MANIPULATING INDIVIDUALS' RISK-TAKING WITH FINANCIAL INCENTIVES: A MYOPIC LOSS AVERSION EXPERIMENT

This study relates to behavioural biases and their influence on individuals' decision making in financial markets. I introduce a new experimental setting which allows testing for myopic loss aversion (MLA) without protecting individuals from their own myopia. Utilizing this experimental design I try to find out whether financial incentives in the form of fees or bonuses can be used to decrease individuals' portfolio reviewing frequency and increase their risk-taking. From the point of view of practical implication my study is aimed on finding out how different financial incentives (positive/negative) can be used to change investors framing and portion invested in stocks.

I also contribute to the existing literature by including tests for overconfidence, gender and occupation differences and their relationship to myopic loss aversion. In addition, I include tests for reactions to gains and losses and present a new hypothetical theory of double mental account, which is aimed to better explain differences in outcome reactions of individuals with different amount of total wealth invested in risky assets in relation to the prospect theory.

DATA

To collect data I constructed an internet based application which involves question sets and an asset allocation game in the form of coin flipping series. Subject group consists of HSE students and market professional. I used real monetary rewards to increase response rate and robustness/comparability of my results.

RESEARCH RESULTS

I find that positive financial incentives in the form of bonuses can be effective in reducing evaluation frequency without decreasing individuals' risk-taking. Manipulations with negative financial incentives were successful in reducing evaluation frequency but failed to maintain risk-taking with low evaluation frequency. I also find that MLA effect does not hold when financial incentive manipulations are applied.

My results show that women placed significantly lower bets than men and had higher evaluation frequency. However, difference in evaluation frequencies of men and women are not statistically significant. I find strong positive relationship between individuals estimating better than average performance and bet size indicating that risk-taking of overconfident individuals is significantly higher.

I find partial appliance with the double mental account theory as individuals with lower than median bets increased their bet after losses to lower extent than individuals with above median bets and the difference is statistically significant.

KEY WORDS

Prospect theory, Myopic loss aversion, Mental accounting, Disposition effect, Overconfidence

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Abstract

In this study I conduct a *myopic loss aversion (MLA)* experiment involving a multi-period asset allocation game. This experiment is mainly aimed on testing whether artificial manipulations with financial incentives can influence individuals' *mental accounting* and increase portion invested in riskier assets. Most of the previous studies on MLA (e.g. Gneezy and Potters, 1997; Haigh and List, 2005) contain experimental settings with fixed portfolio evaluation frequencies given to subjects and main findings indicate that decreased evaluation frequency leads to higher investment in riskier assets. I introduce an experimental setting which allows individuals to choose among several evaluation frequency options thus removing artificial protection against myopia and providing additional variable to subjects' decision making process. Bashears, Choi, Laibson and Madrian (2009) conduct a framed field experiment where they pay individuals for frequent and infrequent reviewing to create variability in reviewing frequency but subjects are able to review their portfolios freely. In contrast to Bashears et al. (2009) financial incentives in my experiment are aimed on reducing number of myopic choices. This setting roughly simulates a real-life situation where financial incentives could be used to reduce portfolio evaluation frequency and increase attractiveness of e.g. stocks. Results obtained from my experiment indicate that although financial incentives successfully reduced evaluation frequency they were effective in increasing individuals' risk-taking only with manipulations involving positive financial incentives in the form of bonuses. Reactions of individuals to gains and losses indicate that risk-taking increased with losses to greater extent than with gains. In addition, I find individuals receiving multiple consecutive gains act in appliance with the house-money effect. Overconfidence associated with *better than average* effect has strong positive influence on risk-taking but no statistically significant effect on evaluation frequency. Females had significantly lower investment in risky assets and higher evaluation frequency. However, difference in evaluation frequencies of men and women is not statistically significant.

Acknowledgements

I want to thank Petri Vilén for helping me to build and conduct my experiment. I also want to thank professors Sami Torstila and Markku Kaustia for making this study possible and for commenting and aiding in information gathering.

1. Introduction

1.1 Background and motivation

This work is inspired by behavioural theories of decision making and their implementation in financial markets. One of the most intriguing problems which raised my interest was the equity premium puzzle first presented by Mehra and Prescott in 1985. In a nutshell, equity premium puzzle revolves around a question related to the behaviour of investors and their investment choices. Why are individuals including government bonds in their portfolios when stock market has continuously outperformed bonds in the long-run? Mehra and Prescott show, that risk aversion of individuals alone can not explain this phenomenon as it must be implausibly high to make investors neglect the high real returns of stocks. Till this day, there is no single explanation that would provide a complete answer to the equity premium puzzle but there are several theories that deal with this problem. My study concentrates on the phenomena presented in one of these theories, namely *myopic loss aversion* and *mental accounting*. Behavioural theory implying *myopic loss aversion* was first introduced by Benartzi and Thaler (1995) as one possible explanation to the equity premium puzzle. Psychological aspects behind myopic loss aversion theory combine mental accounting and loss aversion. If an individual is myopically loss-averse, he wants to evaluate his portfolio as frequently as possible (myopia) and feels losses more than gains (loss aversion). From the perspective of MLA theory, even if riskier asset performs better in the long-run, investors with high evaluation frequency will be dissatisfied more often because of periodic drops in the price of this risky asset. MLA theory suggests that loss-averse but not myopic investor would find risky assets more attractive with longer time horizon and infrequent evaluation. There are numerous studies which find significant presence of MLA within subject groups. Results of some studies also indicate that this phenomenon is not removed by market experience and that market professionals exhibit myopic loss aversion to a higher extent than students (Haigh and List, 2005). I try to capture individuals' asset allocation decisions by presenting experiment participants with an internet based application including question sets and a coin flipping game. This experimental setting is aimed on simulating asset allocation problem with single time horizon and multiple feedback frequencies available. By manipulating individuals' evaluation frequency choices with financial incentives I seek to find whether such manipulations can be used to influence individuals' risk preferences and increase portion invested in riskier assets. In addition, I study effects of evaluation frequency manipulations on different subject groups e.g. males and females; professionals and students, to determine whether there are notable differences in responses among these groups.

Practical implications

The point of interest for real-life implications would be enhancement of risky assets for long-term investors. Financial institutions could manipulate investors' portfolio evaluation frequency without reducing feedback flexibility and consequently make riskier assets more attractive. In my experiment, I use fees and bonuses applied to certain feedback frequencies as financial incentives. The idea behind these financial incentives is to reduce portfolio evaluation frequency but not to limit or restrict it. In comparison to conventional feedback models with predetermined and limited feedback frequency manipulations with financial incentives would not create any reliability issues as investors would be still able to evaluate their portfolios as they choose. Transaction costs can be considered as one example of financial incentives as they make too frequent selling and buying of assets unprofitable. However, transaction costs do not limit reviewing frequency which is the main factor in the MLA theory. Similarly as with transaction costs, too frequent reviewing could be made possible but unprofitable with financial incentives in the form of fees. Bonuses could be utilized in opposite manner when paying for less frequent feedback. Such feedback policy could shift investors' choices away from frequent reviewing possibly changing their framing and increasing portion invested in stocks in appliance with MLA theory. It is important to note, that to be efficient feedback policy has to be bound to investment flexibility i.e. if an investors chooses to receive bonuses for infrequent reviewing she is also unable to rebalance her portfolio more often than she receives feedback. In other words, investment flexibility plays an important role in financial incentive manipulations and is determined as possibility to rebalance ones portfolio. Fellner and Sutter (2009) find that setting low investment flexibility as a default option and charging a fee for changing this option could increase individuals' risk-taking but there are some controversial arguments on whether feedback frequency manipulations can be effective (e.g. Thaler et al., 1997; Bashears et al., 2009) and one of the main purposes of my work is to study more closely whether financial incentives can shift individuals choices away from frequent evaluation and increase portion invested in risky assets.

Market experience and overconfidence factors

As noted above, empirical results suggest that market experience does not remove myopic loss aversion (Haigh and List, 2005), however, it has been shown that there are significant differences in other behavioural aspects of market professionals and other subject groups e.g. undergraduate students. For example, Kaustia, Alho and Puttonen (2008) conduct an *anchoring effect* experiment involving market professionals and undergraduate students. They find that professionals exhibit statistically significant anchoring effect but to a smaller extent than students. In addition, Alvey, Haigh and List (2007) find that market professionals perform better in distinguishing the quality of public signals than the student group. From these findings we can formulate a more general question of whether market professionals frame their decisions differently and whether these differences lead to better performance. To boost relevance of my results I included market practitioners and undergraduate students in my experiment subject group. In addition to market experience factor I include tests for overconfidence as this factor is shown to be related directly to market experience and gender differences. Overconfidence is a behavioural phenomenon which can be observed when an individual believes that he has more accurate information than he actually does and this may lead to more frequent and aggressive trading. Many economical studies address this phenomenon but some controversial results are present. For example, some studies (eg. Gervais and Odean, 2001) find that market experience reduces overconfidence but results from the study by Allen and Evans (2005) suggest the opposite. Analytical studies on overconfidence show that not only overconfident traders are present in the market, but that under certain conditions they can even dominate it. In my model two overconfidence types are distinguished – one relates to miscalibration of probabilities and other to “better than average” effect. By including factors of gender, market experience and overconfidence, I try to analyze their effects on the decision making process in MLA environment.

Gender differences

Economic studies concerning differences in the market behaviour of women and men are typically related to the risk tolerance and competition factors. Babcock and Laschever (2003) explore the possibility that in the labour market gender differences may arise because women are not so good negotiators as men and do not like the process of negotiation. This suggests that competition situations are less attractive to women than men in general. Niederle and Vesterlund (2007) provide support for this theory and find that men are more overconfident and are more likely to participate in competitions. Even when subject group consists of professional traders, women tend to maintain their gender specific characteristics (Beckmann and Menkhoff, 2008) such as higher risk aversion and lower overconfidence. In my study I seek to find whether women frame their decisions more narrowly than men and what effect this might have on their final wealth.

1.2 Relevant studies

In this section I will go through some of my main references which are mostly related to loss aversion, portfolio evaluation frequency and asset allocation decisions. More thorough review of other studies and factors involved in them will be presented throughout the paper in latter sections.

One of the most important papers to which I will refer is the work by Benartzi and Thaler (1995), where they present the *myopic loss aversion* as one possible explanation to the equity premium puzzle. This work is particularly interesting as it combines psychological concepts of mental accounting and loss aversion to explain individuals' behaviour leading to equity premium puzzle. Many experimental studies have shown results that are in line with MLA theory and indicated that effects can be significant. Gneezy and Potters (1997) conduct a lottery experiment in which subjects are presented with a betting sequence of 12 rounds. Authors manipulate evaluation periods of lottery outcomes and find strong presence of MLA. Similar experiment is conducted by Haigh and List (2005) with subject groups including undergraduate students and market professionals. Again, results indicate presence of myopic loss aversion. Thaler, Tversky, Kahneman and Schwartz (1997) experimentally test two implications of myopic loss aversion which are (1) acceptance of higher risk with reduced evaluation frequency and (2) increase in acceptance of higher risk when losses with lowest payoffs are eliminated. Both of these implications had significant effects on individuals' risk preferences and results indicate that subjects who had more frequent feedback took less risk and earned less money.

In behavioural experiment by Benartzi and Thaler (1999), authors present experiment subjects with series of "gamble or invest" choices with constant return distributions. Main findings indicate that showing return distributions to subjects increases acceptance of presented gamble and that workers will invest more in stocks if they are presented with long-term rates of return instead one-year rates. According to Benartzi and Thaler (1999), individuals overestimate their chance of losing assets and thus frame their choices narrowly (Kahneman and Lovallo, 1993). In addition, individuals tend to evaluate each gamble round separately and do not combine them into one long-term sequence.

Myopic loss aversion concept is only one among several theories addressing equity premium puzzle and can serve only as partial explanation to this phenomenon. Some assumptions implemented by Benartzi and Thaler (1995) concerning individual's behaviour and preferences are different from those implemented by Mehra and Prescott (1985). In addition, MLA theory lacks a general model regarding portfolio choice and asset valuation. Mehra and Prescott (2003) present a critical review of proposed explanations to equity premium puzzle and show that many of these explanations fail on crucial dimensions. However, these factors do not remove the fact that myopic loss aversion can be strongly present and have significant influence on decision making of individuals.

As described in paper by Fellner and Sutter (2009) flexibility of investment might play even more important role than feedback frequency. Including three treatments with high investment flexibility (1), low investment flexibility (2) and low investment flexibility plus high evaluation frequency (3) allows authors to distinguish between effects of feedback frequency and investment flexibility. Fellner and Sutter (2009) find that individuals who have lower investment flexibility i.e. are able to change their investment less often, are more likely to have higher portion invested in riskier assets. In addition, authors include tests where experiment subjects are allowed to choose their investment flexibility endogenously and find that there are no clear preferences for either high or low investment flexibility. Manipulating treatments by setting low investment flexibility as a default options and introducing a fee for switching this option (Somewhat similar to Stick treatment in my experiment) seems to have a positive effect on individuals' risk-taking as 75% of subjects keep this option. Results show that MLA effects hold despite default setting manipulations.

In contrast to most of the earlier studies with fixed evaluation frequency treatments Bashears, Choi, Laibson and Madrian (2009) conduct a lasting experiment involving investments in real market assets. They seek to find whether myopic loss aversion can influence risk preferences of individuals and whether manipulations with financial incentives can increase or decrease portion individuals invest in equities. Authors provide real financial rewards for their experiment participants for reviewing their portfolio at designated periods and evaluation frequency is not technically bound by treatments. Main insights of this experimental setting are usage of real market instruments, real rewards, free evaluation frequency and realistic evaluation time periods. Using these experimental settings Bashears et al. (2009) find that MLA could not explain risk preferences of individuals to significant extent but showing past return distributions of stocks and bonds can significantly influence their portfolio consistency.

What comes to reactions of individuals to previous gains and losses there are controversial findings on whether individuals increase or decrease their risk-taking after a gain or a loss. Weber and Zuchel (2005) find that the effect depends on how the asset allocation situation is framed. Authors show that if the experiment is framed as lottery individuals tend to increase risk-taking after a gain more than after a loss whereas if the experiment is framed as an investment portfolio individuals tend to increase risk-taking after a loss more than after a gain.

1.3 Objectives and contribution

In this paper I present a new experimental design for testing different aspects of myopic loss aversion and mental accounting phenomena. Compared to experimental settings used in most of the previous studies, evaluation frequency options of individuals are not predetermined exogenously i.e. individuals are able choose between different evaluation frequencies and in this way there is no artificial protection against individuals' own myopia. For example, Gneezy and Potters (1997) and Haigh and List (2005) use experimental designs implementing lottery setting with frequent and infrequent bet evaluations and find strong presence of MLA among experiment subjects. However, dividing treatments by frequent and infrequent evaluation means that individuals' framing is predefined and subjects are unable to influence their evaluation frequency. In addition, if individuals have only one evaluation frequency available (choosing evaluation frequency is removed from consideration), their perception of the whole problem might be different compared to the one with multiple frequencies available. I argue that removing the possibility to compare prospects with different evaluation frequencies distorts the process of framing and mental accounting and thus ignores one important aspect of decision making process.

Bashears, Choi, Laibson and Madrian (2009) conduct a framed field experiment where they use financial rewards to induce more or less frequent portfolio reviewing. Authors recruited 600 individuals to take part in a financial study where those individuals allocated 325$ among four real mutual funds. To create variability in portfolio reviewing frequencies Bashears et al. (2009) pay half of the individuals for reviewing their investment weekly and other half for reviewing their investment semi-annually. Individuals were free to review and reallocate their investment as often as they wanted not depending on treatments. Results indicate that these procedures were effective and individuals who were paid for weekly reviewing logged in to the experiment application more often than individuals with semi-annual payment. However, authors also show that evaluating portfolio more frequently did not lead to significant reduction of portion invested in equities and thus manipulating evaluation frequency might not lead to higher investment in risky assets as suggested by the results of previous studies e.g. Thaler et al. (1997). Interestingly, Fellner and Sutter (2009) find that the effect of reduced investment flexibility can be even more important than the effect of reduced feedback frequency. As investment flexibility factor is lacking in the experiment by Bashears et al. (2009) i.e. investors can rebalance their portfolios as often as they choose, I can assume that this factor could be crucial from the point of view of individuals' risk-taking manipulations. Unfortunately, I became aware of the study by Fellner and Sutter (2009) only after my experiment was completed and my experimental setting does not distinguish between effects of investment flexibility and feedback frequency. Despite this, evaluation frequency options provided for my experiment subjects contain investment flexibility as well as feedback frequency factors and individuals who choose to receive infrequent feedback are also decreasing their investment flexibility. In contrast to Bashears et al. (2009), I try to manipulate evaluation frequency choices of my experiment participants by using different (positive and negative) financial incentives that encourage only less frequent evaluation. Rather than defining evaluation frequency by treatments, my experimental setting has three different evaluation frequency options in each treatment and treatments differ only in terms of financial incentives provided for these options. The objective is to find whether such incentives can reduce myopic choices of individuals and through that increase portion invested in risky assets. From abovementioned points my contribution to existing studies can be summarized as:

(1) Presenting new design for myopic loss aversion experiment with available evaluation frequency options. My experimental setting includes three treatments which differ in terms of financial incentives provided for evaluation frequency options (Most of the previous studies use fixed evaluation frequency in treatments e.g. Gneezy and Potters (1997), Haigh and List (2005)). In addition, my experimental setting takes a form of continuous 12-period investment process where all returns are accumulated. Experiment subject groups include both market practitioners and students. I also utilize real monetary rewards instead of hypothetical ones to increase relevance of my results. I believe that by including these factors I am able to better capture the decision making processes in an asset allocation setting.

(2) Determining influences of manipulations with financial incentives (aimed on reducing frequent portfolio reviewing) on individuals' risk preferences. Fellner and Sutter (2009) manipulate their experiment subjects' risk-taking by including treatment where low investment flexibility is set as a default and a fee is charged for changing ones investment flexibility. They find that such manipulation is effective in increasing risk-taking as majority of individuals do not shift away from the default low flexibility option (Although more individuals shift from low to high flexibility than vice versa). In their experiment Bashears, Choi, Laibson and Madrian (2009) did not find support for significant influence of MLA on risk preferences and their results suggest that manipulations involving financial incentives could be not effective in increasing investors' risk appetite. I use these studies as my main references and add to them by introducing experimental design with three different evaluation frequency options which

differ in terms of financial incentives by treatment. In ”Carrot” treatment individuals are paid only if they choose low evaluation frequency and in “Stick” treatment individuals are charged for choosing high evaluation frequency. In this way, individuals are unable to review their portfolio more or less frequently than designated by the evaluation frequency option they chose. On the other hand, individuals do not receive extra payment if they choose more frequent evaluation option in “Carrot” treatment and are not charged if they choose to evaluate less frequently in “Stick” treatment. Compared to Bashears et al. (2009), who pay individuals for weekly reviewing in one treatment and for semi-annual reviewing in other treatment (and individuals can review their portfolios as often as they choose), financial incentives in my experiment are aimed on shifting individuals’ choices away from frequent reviewing instead of only creating variation in evaluation frequencies. In addition, I include “Basic” treatment which does not involve financial incentives for any evaluation frequency option and thus serves as a base for comparison to other treatments. I also conduct tests for effectiveness of different financial incentives such as bonuses and fees and try to determine whether ones are more efficient than others in terms of reducing number of narrowly framed choices.

My second objective is to conduct tests on gender differences and differences in behaviour of students and professionals in MLA environment. Main purpose of these tests is to identify whether there are substantial influences of gender and experience factors on the evaluation frequency and final wealth of individuals. In their study, Haigh and List (2005) find that professionals are subject to MLA to greater extent than students and I try to confirm this finding in my experiment. As Barber and Odean (2001) find that women trade less than men, I seek to find whether women frame their choices more widely and whether this behaviour is positively reflected in their final wealth. On the other hand, women could also frame their choices more narrowly (have higher evaluation frequency on average) and have lower investments in risky assets because of their higher risk aversion (Olsen and Cox, 2001). Relating to my first objective, I also study differences in responses to different types of financial incentives (bonuses and fees) among males and females (Fryer, Levitt and List (2008) find that males respond better to financial incentives). My contribution to existing literature on these topics can be formulated as:

(3) Seeking to find whether females are more myopic than males and whether this factor can partially explain lower portions invested in risky assets. To my best knowledge there are no studies addressing this topic directly. Haigh and List (2005) find that professionals are subject to disposition effect to greater extent than students. I include both professionals and students in my experiment to control for the experience factor.

My third objective is to link factors of gender, market experience and myopic loss aversion to overconfidence. In other words, I try to discover what individual characteristics are related to being overconfident and to what extent. Earlier studies have identified that overconfidence is related to higher trading volumes and being a male (Glaser and Weber, 2007). Also market experience has been shown to have an effect on overconfidence but findings are somewhat controversial (Gervais and Odean, 2001; Allen and Evans, 2005). In my experiment I identify two main types of overconfidence which are related to miscalibration of probabilities and "better than average" effect.

(4) Previous papers have studied relationships between overconfidence, gender, experience and trading volume e.g. Glaser and Weber, 2007; Gervais and Odean, 2001; Allen and Evans, 2005. I contribute to earlier studies by testing for these parameters in MLA setting. By doing so I seek to find whether more overconfident individuals choose to evaluate their portfolio more often and have higher portion invested in risky assets.

My final objective is to discuss a theory related to mental accounting and disposition effect. It has been shown that propensities to sell risky assets do not change according to the prospect theory explanation of the disposition effect i.e. according to prospect theory individuals would sell more risky assets further in the domain of gains (Kaustia, 2008). From this empirical finding, I discuss a hypothetical theory involving double mental account approach with commission and omission mental accounts. According to this theory, individuals consider saved losses and missed gains along with occurred gains and losses, and the total assets available to invest serve as a reference point. This theory tries to capture observed behavioural tendencies and partially explain why tendencies to sell risky assets do not increase further in the domain of gains.

(5) I discuss a new theory related to mental accounting in an asset allocation situation. Kaustia (2008) finds that prospect theory can not serve as such to explain disposition effect in real markets. By introducing theory of double mental accounts I try to shed light on how individuals might interpret signals from outcomes of their investments. I discuss this theory in Section 2.9.4.

1.4 Key terms and definitions

This section presents brief description list of key terms that are often used further in this study. More detailed review of these concepts will be discussed in later sections.

Mental accounting

Mental accounting can be defined as individual's personal feature which determines how this individual processes and sorts received information. Mental accounting often refers to an implicit process by which individuals evaluate economic outcomes e.g. transactions, investments and gambles (Kahneman and Tversky, 1984; Thaler, 1985). Mental accounting also refers to certain methods people use when aggregating utilities from available choices and prospects. For example, in the behavioural life-cycle hypothesis (Shefrin and Thaler, 1988) people mentally frame assets as belonging to current income, current wealth or future income. Mental accounting is an important concept from the point of view of this study because it is responsible for perceptions of gains and losses.

Loss aversion

Loss aversion refers to the tendency of individuals to be more sensitive to reductions of their wealth than to its increases. This concept is more thoroughly introduced in the *prospect theory* by Kahneman and Tversky (1979) in Section 2.3. Generally, it can be said that loss aversion leads to risk aversion. Empirical studies show that individuals "feel" losses approximately two times more than gains.

Risk aversion

Risk aversion refers to the tendency of individuals to accept bargain with lower expected payoff rather than to accept bargain which has higher expected payoff but is less certain.

Myopic loss aversion

Myopic loss aversion is derived from concepts of mental accounting and loss aversion. A myopically loss-averse individual feels losses more than gains and evaluates his investment frequently, thus inducing narrow framing. This concept was first introduced by Benartzi and Thaler (1995), and serves as one of the explanations to the equity premium puzzle.

MLA preferences

Preferences of myopically loss-averse individual include (1) frequent portfolio evaluation and (2) avoiding/reducing investment in risky assets.

Investment flexibility

Investment flexibility determines frequency at which investors are able to rebalance their portfolios. Low investment flexibility does not exclude high feedback frequency as individuals may be able to review their portfolios but are unable to rebalance them.

Overconfidence

Overconfident individual believes that he has more accurate information than he actually does. This person may also believe that he possesses more and better information than the majority. In addition, overconfidence can be related to miscalibration of probabilities and wishful thinking. More thorough discussion concerning overconfidence can be found in Section 2.6.

Behavioural biases

Are biases that arise from individuals' psychological characteristics and nature. Some behavioural biases are suggested as an explanation to various market anomalies and some of them are considered systematic e.g. overconfidence.

Systematic biases

Behavioural biases can be systematic i.e. they are not cancelled out by large sample size and thus may cause systematic decision shifts in one particular direction. Systematic biases are also argued to be the proof of market irrationality and many behavioural experiments are based on them.

Availability

The concept of availability refers to the ability of an individual to retrieve information from his memory and to process it accordingly. It has been shown that availability plays a major role in how individuals presume events and probabilities. Availability heuristics are described in more detail in Section 2.

Value function

The prospect theory value function displays relative utility to an individual from additional gains and losses compared to initial reference point. According to this function, marginal utility from additional gains decreases further in the domain of gains and marginal negative utility from losses decreases further in the domain of losses. This function is sketched in Figure 1.

Reference point

Initial reference point can be described as a state of wealth to which an individual compares current and future outcomes. Taking reference point into account, individuals consider some changes in wealth as gains (above the reference point in the domain of gains) and other as losses (below the reference point in the domain of losses). This concept is a base for the prospect theory and is described in Section 2.3.

1.5 Limitations

This study involves behavioural experiment with undergraduate students and market professionals from Finland. Technically this experimental design is not limited to one country as it is conducted via internet, however, in this study I limit my sample to undergraduate students from Helsinki School of Economics (HSE) and market professionals from listed Finnish companies. HSE students are included as a student group because they are potential market professionals and their behaviour can be seen as more relevant from the perspective of asset allocation decisions.

Recent studies suggest that results from experiments utilizing hypothetical money can not be comparable to those utilizing real money. To make my results more relevant I include real money rewards and individuals' actual return depends on their performance in the experiment. This study is limited to small stakes (the initial game unit amount available to individuals is 1000 units = 5 €). Taking this into account, I am not able to conduct tests on whether there are differences in asset allocation choices with small and big stakes (Benartzi and Thaler, 1999). I try to compensate for the disadvantages of small stakes by introducing a possibility to donate gained money to charity. In this way I try to induce additional incentives along with increasing one's own wealth. My study is also limited by experimental design, its features and data collected. As I use 12-round coin flipping game to simulate investors' portfolios, this experimental setting can not provide results directly comparable to real-life investments, thus relevant comparison can be made only between results acquired from similar experimental settings.

It is important to note, that the nature of experiments conducted via network limits controlling possibilities over these experiments. This means that subjects could take their time and search literature or other sources to try to boost their performance. On the other hand, small stakes involved in this experiment are hardly motivating enough to encourage subjects to put extra effort on searching additional information. Internet based nature of experiments could also contain self-selection bias as it can be argued that the sample group will include only those individuals who are more likely to respond to electronic participation invitations. However, majority of my experiment subjects are undergraduate students from HSE where e-mail based communication is the most common way to receive and send information, thus self-selection bias is minimized compared to populations with varying communication cultures.
Another relevant limitation is the sense of time in the experiment. Participants are told that this experiment will take them approximately 5 to 10 minutes to complete. It is clear that such time

setting is not comparable with real-life investment horizons, thus factors arising from time sense of investors may not be fully captured.

1.6 Structure of the study

The paper is organized as follows. In Section 2 I will go through most relevant theories and previous papers on the topic of my study. This section includes discussion about decision making process and behavioural biases influencing this process as well as main principles behind the prospect theory and myopic loss aversion. Section 3 presents main hypotheses derived from theories discussed in Section 2. These hypotheses are related to MLA, overconfidence and gender differences. Section 4 presents experimental design and methodology implemented in this paper. In this section I describe thoroughly how my experiment was constructed and what are the main points and factors taken into account. Results and analysis are presented in Section 5. Section 6 concludes this paper.

2. Decision making process and behavioural biases

Before presenting main hypotheses and experimental design it is important to review theoretical background behind them. In this section I discuss previous studies addressing psychological and behavioural aspects of decision making under uncertainty as well as some of the most important theories and biases.

2.1 Cognitive process of decision making

Similarly to all individuals, actors in the financial markets take perceptions and feelings into account when reacting to certain events. Although experience, specific knowledge and professional tools serve as a starting point for these reactions, it is essential to fully appreciate the importance of psychological aspects and possibility of occurring systematic biases. Main purpose of this section is to discuss basic framework of cognitive processes which is commonly recognised and used to explain decision making of individuals in some specific situations.

2.1.1 Two-system approach

The distinction between intuition and reasoning is one of the core assumptions when analyzing decision making process. Prize lecture by Kahneman (2002) summarizes main ideas and principles behind the two-system approach and presents plenty of examples how these systems influence perceptions of individuals. In a nut shell, System 1 is responsible for fast, automatic and effortless cognitive processes as when System 2 is responsible for deliberate, systematic and slower ones. A simplified example can be as follows: If you see a car, System 1 automatically creates impressions which are based on initial perceptions from this car, such as expensive or fast. System 2 becomes more involved when you deliberately try to estimate how expensive or fast is this car, perhaps by bringing into mind performance or speed of similar cars. However, System 2 is always involved in cognitive processes where judgement is present but the extent of this involvement may differ. The importance of the two-system approach becomes clear when we consider quality of decisions based purely on intuition. The problem is that intuition is often insufficient to make plausible judgements not even mentioning making optimal choices. The extent to which intuition is present in final judgements depends largely on System 2 and the effort individuals are willing to make when analyzing outcomes produced by System 1. Of course, cognitive processes are individual-specific and construction of a single general model is somewhat impossible. None the less, there are certain tendencies which may apply to the majority of individuals and thus understanding these tendencies and cognitive processes behind them can help to establish relationships between individual-specific characteristics and build generalized expectation models. From economic and financial perspectives cognitive processes are important because they can result in systematic biases and cause behavioural anomalies breaking conventional rules of market perfection. Fortunately, most biases cancel each other out when the whole population is considered and in my study I try put more emphasis on systematic biases.

2.1.2 Concept of accessibility

An important concept behind many behavioural biases is *accessibility* of information, which determines how effectively an individual can retrieve and process some specific piece of information from his memory. One dimension of accessibility is the sufficiency of perceptive information i.e. the information that could be acquired with minimal implementation of System

2. In other words, you can say that the height of a tower is more accessible compared to the cumulative volume of building blocks of this tower. Similarly, you can say that equity premiums for the last year are more accessible compared to equity premiums for the last twenty years as the first ones are more salient in one's mind. Accessibility is also related to the effort and number of iterations one has to make to come to required solution. If you asked someone to estimate future returns of a specific stock this person would have to take into account various factors including industry specific returns, overall company status, general trend in the economy etc. It is clear, that bearing all these factors in the memory is not very common and the extent to which such information can be retrieved varies among individuals. Again, simply retrieving information from one's memory is not enough but it must be processed and analyzed to reach the final estimate. These two factors of retrieving and processing often result in a tedious task for individuals trying to form their judgement and usually require some incentives to reward such effort. I will refer to the concept of accessibility throughout my paper as it comes in handy when analyzing decision making processes and behavioural biases related to them.

2.2 Equity premium puzzle

The equity premium puzzle presents us with a fact drawn from past US data showing that risk aversion of investors must have been implausibly high to explain the large difference between returns on government bonds and stocks. The point is that in the real world there are hardly individuals who are so risk averse to ignore significantly more attractive stock returns in the long-run, thus there must be some irrationality in the market. First presented by Mehra and Prescott (1985), the equity premium puzzle has no single explanation. As shown by authors (Mehra and Prescott, 2003) majority of suggested solutions fail along crucial dimensions and this is why there is no single theoretical solution for this puzzle.

In this paper I study one of the theories attempting to explain the equity premium puzzle. The *myopic loss aversion* theory (Benartzi and Thaler, 1995) approaches the problem from psychological perspective and includes concepts of mental accounting and narrow framing of decisions. What makes MLA theory especially interesting is its confirmation with various laboratory experiments by multiple authors. If MLA can be shown to significantly influence decision making of investors in the market, it could open ways for new methods to manipulate individuals' judgements to induce higher or lower investments in risky assets. In addition to myopic loss aversion theory, other plausible explanations to equity premium puzzle concentrate on equity based characteristics such as demand for liquidity (Holmstrom and Tirole, 1998).

2.3 Prospect theory

One of the essential background theories in this study is the *prospect theory* presented by Kahneman and Tversky in 1979 and updated to *cumulative prospect theory* in 1992. Prospect theory is an alternative and more complete framework explaining individuals' decisions making under uncertainty and clarifies certain inconsistencies which could not be explained by *expected utility theory* of Von Neuman and Morgenstern (1953). Main insight of the prospect theory is the way in which individuals are considered to make their decisions i.e. individuals do not make decisions based on final wealth opportunities and their probabilities (as in the expected utility theory) but based on values assigned to gains and losses with respect to moving reference point and decision weights. Prospect theory is implemented as a base theory in many economic studies and gives ground for further extensions and supplements. Kahneman and Tversky (1979) find that individuals prefer certain gains to a gamble even though the expected outcome of this gamble is larger and should be preferred according to the expected utility theory. On the other hand, individuals prefer a gamble to certain losses even though the setting is otherwise similar. Authors call this phenomenon a *reflection effect* and it implies that gain prospects are reflected in the domain of losses. This phenomenon can partially explain why individuals become risk-averse in the domain of gains and risk-seeking in the domain of losses. Another inconsistency with expected utility theory, referred to as a *certainty effect*, is that individuals tend to prefer certain outcomes to 99% certain ones even if the expected outcome was higher in the latter. In addition, it is shown that small probabilities can be overweighted and thus individuals may have an insurance policy and buy lottery tickets at the same time. In prospect theory *isolation effect* refers to the tendency of individuals to make choices based on relative changes in their wealth rather than the final wealth. Again, this effect demonstrates that expected utility theory fails to take into account relevant aspects of human behaviour.

According to the prospect theory, a decision making process consists of two stages: editing and evaluation. In the editing phase an individual goes through heuristic processes of coding, combination, segregation and cancellation. These processes affect how different prospects are comprehended and through that allow for further evaluation (This behaviour is consistent with two-system approach in Section 2.1.1).

Coding.

As prospects are later evaluated in terms of increases or decreases of initial wealth, one must determine a reference point that defines possible outcomes as gains and losses. Usually reference point is set at the initial wealth or initial price of an asset. This would intuitively seem reasonable assumption because decreases in current wealth will be considered as losses and increases as gains.

Combination.

This cognitive process refers to the tendency of individuals to combine probabilities of identical outcomes. For example, gaining 100€ with ¼ probability or gaining 100€ with ½ probability could be perceived as gaining 100€ with ¾ probability.

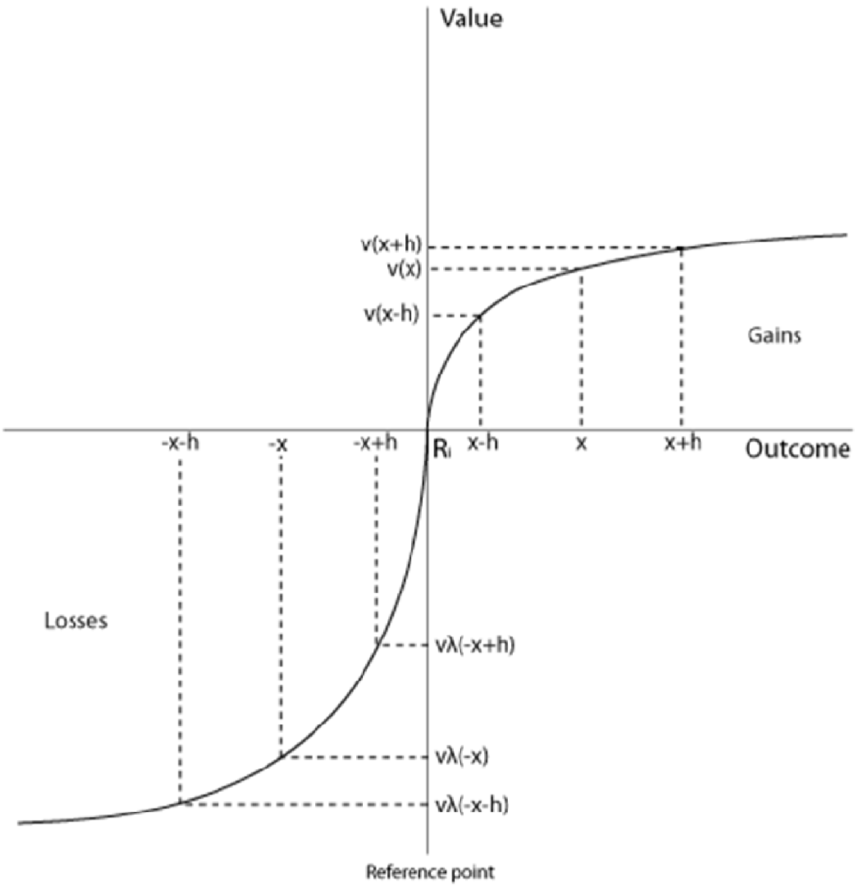
Segregation and cancellation.

Individuals may segregate riskless or certain components of prospects and consider a possibility to win 100€ with ¼ probability or to win 300€ with ¾ probability as ¾ probability to win 200€. Same applies when loss prospects are considered i.e. loosing 300€ with ¾ probability or loosing 100€ with ¼ probability is perceived as ¾ probability to loose 200€. Individuals also tend to ignore common stages of available prospects. In other words, if there is a ½ chance to win 1000€ and ½ chance to win nothing (first stage) and if you win the 1000€ there is a possibility to choose a ½ chance to win 500€ and ½ chance to win 50€ or a certain win of 200€ (second stage), individuals will ignore the first stage with ½ chance to win nothing and will consider only second stage of prospects. As a result of the editing phase a reference point is set and available prospects are determined. In the evaluation phase individuals evaluate prospects that are attainable to them by assigning certain values to outcomes and their probabilities. A simplified version of the utility function can be written as:

$$U = w(p_1)v(x_1) + w(p_2)v(x_2) + ... + w(p_n)v(x_n) \qquad (1)$$

where $x_1, x_2, ..., x_n$ are potential outcomes, $p_1, p_2, ..., p_n$ are corresponding probabilities, v is drawn from the prospect theory value function (Figure 1) and w is drawn from the probability weighting function (Figure 2) which indicates that small probabilities are overweighed and large and medium probabilities are underweighted.

Figure 1: Prospect theory value function



This function depicts the value of a prospect for an individual in the domain of gains and losses. The function is concave in the domain of gains representing the diminishing utility from increasing gains. Value function is convex in the domain of losses representing the diminishing negative utility from additional losses. Function is steeper in the domain of losses meaning that gains and losses of equal magnitude are valued differently i.e. losses are valued more than gains.

Prospect theory is especially useful because it can attain explanations to such phenomena as disposition effect, anchoring effect and other systematic biases observed in the field. Despite its breakthrough-like insights prospect theory leaves room for further development and enhancements as there are no general models for decision making process under uncertainty. I use prospect theory assumptions as a base for my experimental design and also refer to it in my hypothesis and results.

2.3.1 Loss aversion and the prospect theory

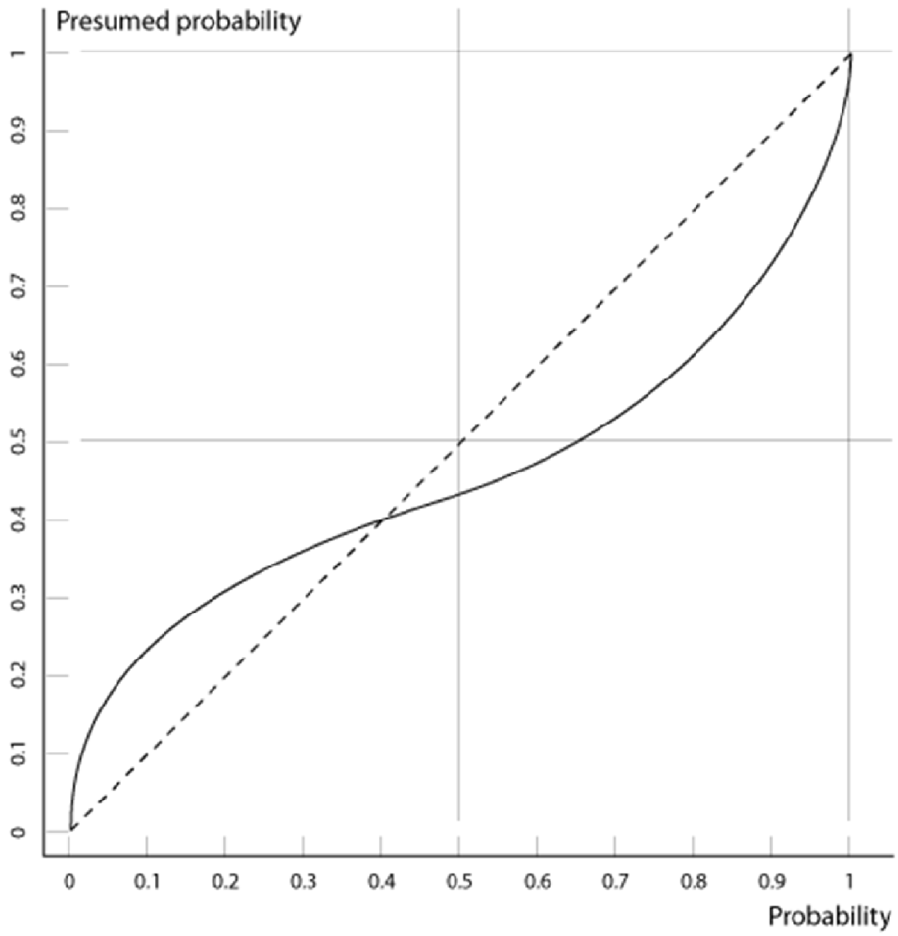
The impact of loss aversion can be observed when individuals are unwilling to take fare gambles, say 50% chance to win 10€ and 50% chance to lose 10€, and shed away from gambles with positive expected outcomes. Loss-averse individuals perceive losses and gains differently and the impact of losses on their utility is greater than the one of gains. Loss aversion is indicated in the value function of the prospect theory (Figure 1) which is steeper in the domain of losses. When an individual is at his reference point R_i , all values below this reference point are perceived as losses and above it as gains. In other words, aggregated utility from prospects of moving from the reference point to the positive outcome x or negative outcome $-x$, is negative to a loss-averse individual because losses are weighted more than gains by loss aversion coefficient λ. We can express this as $v(x) + v(-x)\lambda < 0$ (Figure 1). Concavity in the domain of gains and convexity in the domain of losses can also explain changing risk preferences of individuals when they move further in domains of losses or gains.

2.3.2 Disposition effect and pseudocertainty

The disposition effect can be described as a market anomaly which is reflected as a tendency of investors to sell shares which have risen in value and keep shares with plunging values. The prospect theory and its value function are suggested as one possible explanation to this phenomenon. It has been shown that individuals become more risk-averse after experiencing gains and risk-seeking after experiencing losses. This phenomenon has been also referred to as a *pseudocertainty effect*. In their article, Dacey and Zielonka (2008) provide a detailed explanation on how the disposition effect is derived from S-shaped value curve. In other words, if there is a positive outcome x and corresponding value $v(x)$ (Figure 1), an individual will value the prospect of additional gains $+h$ less than the prospect of potential losses $-h$, thus $v(x+h)-v(x) < v(x)-v(x-h)$.

On the other hand, if a loss –x occurs, the same individual will try to compensate for it and potential gain of +h will be valued more than additional loss of –h, this can be expressed as $v(-x+h)-v(-x) > v(-x)-v(-x-h)$. Aggregated utility of available prospects in both domains explains why individuals may be risk-averse in the domain of gains and risk-seeking in the domain of losses. Another phenomenon, which can be linked to the disposition effect is the *status quo bias*, which is observed when individuals try to balance their choices so that to avoid fluctuations from the initial state.

Figure 2: Presumed probability function



This function represents the empirical relationship between real and presumed probabilities. It shows that small probabilities are overestimated and large and moderate probabilities are underestimated.

There are other psychological factors that may explain the disposition effect, for example, individuals may try to avoid regret or seek pride. Some theories suggest that investors are reluctant to recognise poorness of their decisions and accept their lack of sufficient analytical ability (Hirshleifer, 2001). Trying to avoid closing mental account at a loss may also be one reason to keep assets in the domain of losses, as proposed by Shefrin and Statman (1985). However, the value function provides only generalized insight on how disposition effect may be explained. For example, despite supporting results for persistent existence of the disposition effect in the market (Kaustia, 2004), the prospect theory alone is not likely to explain this effect completely. As shown by Kaustia (2008), empirical propensity to sell stocks is increasing or constant in the domain of gains and approximately constant in the domain of losses. At this point it can be noted, that country-specific factors can influence the extent to which disposition effect is present e.g. Chen, Kim, Nofsinger and Rui (2007) show that Chinese investors are subject to disposition effect to greater extent than U.S. investors.

2.4 Myopic loss aversion

As mentioned in the introduction section, the emphasis of my study is on myopic loss aversion theory and its possible application to financial instruments. First, introduced by Benartzi and Thaler in 1995 as one possible explanation to equity premium puzzle, MLA theory suggests that risk taking preferences of investors depend crucially on their portfolio evaluation frequency. This can be also illustrated by widely known example which appears in papers of Benartzi and Thaler (1995); Thaler, Tversky, Kahneman and Schwartz (1997); Gneezy and Potters (1997). This example was first presented by Samuelson in 1963. An individual was asked if he would place a bet in which he would have a 50% chance to win 200$ and an equal chance to lose 100$. This individual turned down the bet but said that he would be happy to accept 100 of such bets. A rationale behind the decision to reject the bet was formulated by this individual as he would feel the loss of 100$ more than the gain of 200$. In a simplified utility function form this can be expressed as:

$$U(x) = x \quad x \geq 0 \text{ ; } U(x) = 2.5x \quad x < 0 \tag{2}$$

where x is relative change in wealth compared to the status quo.

A single bet with abovementioned utility function and properties is unattractive as it returns negative utility 0.5 x 200$ + 0.5 x (-100$) x 2.5 = -25$. However, if we consider similar bet repeated two times, utility function will return 0.25 x 400$ + 0.5 x (200-100) + 0.25 x (-200$) x 2.5 = 25$, which is positive. This applies as long as this bet is not viewed as two separate bets and intermediate outcomes have no effect on individual's mental accounting. This example illustrates the core logic behind myopic loss aversion. If an investor considers investing in a risky asset, this asset will appear more attractive the longer the investment horizon and the lower the evaluation frequency. If investor has short evaluation periods and is highly loss-averse he will reduce his portion invested in risky assets because temporary losses will be weighted more than temporary gains. Investors with these preferences can thus be defined as myopically loss-averse. Technologies such as internet and internet banking applications enable more investors to take part in the securities markets and enable quicker and cheaper transactions (Barber and Odean, 2001. *Journal of Economic Perspectives* 15). From MLA perspective, there can be remarkable implications of such technological development because now more frequent portfolio evaluation is available and investor segments are more versatile.

Gneezy and Potters (1997) conducted an experiment involving lottery setting. Their subjects were presented with possibilities to place portion of granted money on a chance to win 2.5 times the bet with probability of 1/3 and to lose the whole bet with probability of 2/3. Frequent and infrequent treatments were used to control for evaluation period. In frequent treatment the lottery was played for 12 rounds and individuals were able to place bets in each round. In infrequent treatment individuals placed bets in bundles of three. Results of this experiment support the MLA theory as subjects tended to place larger bets in infrequent treatment.

In their experiment, that is similar to the one mentioned above, Haigh and List (2005) fill the research gap by including and comparing myopic loss aversion of professional traders to the one of undergraduate students. Results show that both groups are subject to MLA but professionals are myopically loss averse to a greater extent than students.

In the experiment by Thaler, Tversky, Kahneman and Schwartz (1997), subjects were asked to invest in two hypothetical funds, A and B. The experiment was constructed so that individuals had to learn about fund characteristics (risks and returns) from experience. Subject groups had different feedback frequency and as a result subject with frequent feedback took less risk and earned less money. Additional confirmation for MLA presence is shown in the work by Benartzi and Thaler (1999).

It would seem that if MLA assumptions hold investors would increase stakes in risky equities if their portfolio evaluation frequency was reduced. However, most confirmations of MLA come from laboratory experiments and thus significance of these results may not apply in real markets. In contrast to common laboratory studies Bashears, Choi, Laibson and Madrian (2009) conduct an experiment which is modelled to represent investment conditions more realistically. They recruit individuals who are asked to invest their money in real market assets. Interestingly, authors do not find that evaluation frequency would increase risk taking significantly and thus MLA may not be a significant factor for answering the equity premium puzzle. In addition, this would mean that financial instruments created to enhance attractiveness of reviewing aggregated returns will fail to manipulate mental accounts of investors. None the less, Bashears, Choi, Laibson and Madrian (2009) find that showing historical return distributions increases preferences for equities. This implies that individuals do not recall or are unfamiliar with magnitudes of equity premiums and adjust their choices when new information is revealed. Taking into account these controversial findings related to influences of MLA on risk preferences it is hard to draw a single conclusion. Despite this, it is possible that unawareness of investors leads to underestimating equity premiums and overestimating associated risk. With these assumptions it could be rational to hypothesize that investors who are concerned only in relatively short-term returns are also interested only in relatively short-term historical returns when making their investment decisions. In this sense, the whole picture of large differences in premiums of stocks and bonds is deluded or never formed in investors' minds.

2.5 Disclosure frequency

If we assume that the effect of myopic loss aversion has a significant impact on risk preferences of individuals and on their final wealth, then there must be a way to reduce this effect and construct financial instruments so that to encourage individuals' higher risk taking and less frequent portfolio evaluation. However, the problem is that simply disclosing information less frequently may lead to trust issues with severe consequences and thus reduce attractiveness of such financial assets. As shown in the study by Jo and Kim (2007), disclosure frequency is positively associated with post-issue performance. Despite this, the relationship is not straightforward as Ge and Zheng (2005) discuss in their paper. Authors indicate that well performing funds with low disclosure rate outperform their frequently disclosing peers, but on the other hand, less trustworthy and worse performing funds with low disclosure frequency underperform their peers with higher disclosure frequency. From these findings we can summarize that the question of trust plays an important role when it comes to disclosure rates but in addition there might be MLA effects among peers which are equally trustworthy.

2.6 Overconfidence effect

Overconfidence is one of behavioural biases which can be described as systematic and for this reason I would like to address it more extensively. Overconfidence factor is also closely related to my experimental design and included in my key hypotheses. In later sections I link overconfidence to gender differences and market experience.

Overconfidence is said to be present when individuals believe they possess better information that others. In addition, overconfident individuals believe they can achieve "better than average" performance. To summarize the two abovementioned definitions we could say that overconfidence is usually related to miscalibration of probabilities e.g. overestimating chances of success, and wishful thinking e.g. believing that one has better information or skills. For example, concept of Bayesian probability refers to probability as a state of knowledge rather than more common statistical interpretation. It is important to note that overconfidence is very common among all subject groups and overconfident individuals form a majority of all market actors.

In his study, Odean (1998) shows how overconfidence can influence market efficiency and costs to society. Main findings indicate that overconfidence increases trading volume but at the same time decreases expected utility of traders due to high costs of information acquisition. In other words, overconfident traders tend to trade too much, endure high transaction costs and spend too much time on acquiring information. Another important theory is that if there are many overconfident traders in the market they may distort information signal received by rational traders by underreacting to this signal. This effect might be induced by the belief of overconfident traders in better quality and relevance of their own information i.e. they may underreact to public signals. As a result, overconfident individuals tend to place higher weights on private, salient and implicit information than on highly relevant public information. Again, here we can refer to the concept of miscalibration of probabilities and Bayesian.

By trading frequently investors try to beat the market but eventually fail to do so because of high costs of frequent trading. Barber and Odean (2000) show that households reduce their investment utility by trading frequently and thus destroy their wealth. In this sense, we can link effects of overconfidence to myopic loss aversion as in both concepts frequent trading leads to reduced final wealth. Still, it is important to understand differences between effects of overconfidence and myopic loss aversion as distinguishing them might not be straightforward. For example, overconfident individuals tend to take higher risks and thus their loss-aversion is initially low, but at the same time these individuals tend to trade more and thus their evaluation frequency is increased i.e. indicating narrow framing and myopia. In this setting an important question is whether individuals learn from experience and whether experience can reduce overconfidence or myopia.

Despite various experiments and studies on the topic, the link between overconfidence and market experience could not be presented without contradictions. As suggested by Gervais and Odean (2001), an investor learns from his overconfidence and is able to compensate for this factor in future decisions. On the other hand, Allen and Evans (2005) can not confirm this and find that experience did not reduce overconfidence. One common link between overconfidence and trading volume seems to be that individuals who believe they are better the average trade more. In the study by Glaser and Weber (2007), authors conduct an experiment on overconfidence and find that individuals who have traded below the average in the past are more likely to trade more in the future but also that overconfidence defined by measure of miscalibration does not seem to be significantly related to trading volume.

Following these controversial findings I want to discuss an example involving certain logic why market experience could or could not reduce overconfidence. First, I want to hold to an assumption that overconfidence is a dynamic factor and is adjusted by past experiences i.e. past gains and losses. Second, I assume that there are numerous types of information that investors consider when making their decisions, but for simplification I define only two types. We can say that one type of information (Type 1) under consideration is the historical data, which represents past returns and past performance of companies. This data is available for all investors and can be freely obtained. The second type of information (Type 2) is related to the returns of specific assets that were included in the portfolio of an investor and thus contains factors of experienced gains and losses that have influenced investors' wealth. Investors with low or no market experience do not posses the second type of information because they have only few or no previous investments and thus have to base their decisions on other sources of information e.g. the historical data. From this logic we can draw that learning from experience may influence the decision making process because different types of information are involved. However, it is not clear how overconfidence is influenced and how the market experience is involved. I stated earlier that overconfidence is a dynamic factor and is assumed to increase with gains and to reduce with losses. From this I hypothesize that narrowness of framing can influence overconfidence, because, as discussed in the MLA section, the range of decision framing may influence the very assimilation of gains and losses (As in the colleague example by Samuelson, 1963). If an individual is not aware of temporary losses within the investment period, those losses never occurred for this particular individual and are not reflected in the second type of information. This means that with positive expected returns, gains are experienced more often than losses with longer evaluation periods and an individual may not realize the extent of volatility within these investment periods. On the other hand, if an individual frames his decisions narrowly, he may experience relatively more losses and gains than the investor with longer reviewing period. In other words, frequent trading produces more references for the second type of information and thus there are more factors that could make an individual to adjust his overconfidence level. If these references are mostly positive, they may increase overconfidence gradually instead of adjusting it downwards. In addition, seemingly systematic series of successes or gains, that were due merely to good luck, may result in individual's overestimation of own skills and thus increase weight assigned to the second type of information and through that increase overconfidence. From the abovementioned rationale we can assume that market experience may reduce overconfidence due to more reference factors of gains and losses but may also increase it if those references are biased toward gains. The question could now be formulated as: does myopic framing reduce overconfidence factor? Obviously, the example and rationale discussed above are simplified to great extent and in real life investors may not have fixed reviewing periods and they are also subject various factors that may not be even logically related to the investment decision, thus making it difficult to distinguish between effects of overconfidence and these factors. Despite this simplification, learning from experience is reflected in many behavioural aspects and there is no reason to believe that it does not affect overconfidence or loss aversion. To summarize my arguments on the relationship between overconfidence and evaluation period, I state that frequent evaluation could make individuals to adjust expectations and reduce their overconfidence factor sooner than with longer evaluation periods due to more outcome experiences and also more salient probabilities of short-term outcomes. On the other hand, this implies that if individuals have frequent evaluation periods they also risk becoming myopically loss-averse and diminishing their final wealth. Following these statements, it would seem rational to first adjust your behavioural factors and preferences by reviewing your investment frequently and then to extend your evaluation period to avoid myopic framing. However, in real-life situations this kind of behaviour could not be naturally expected, because individuals who have certain evaluation frequency are unlikely to change this frequency due to various behavioural biases which are discussed in Section 2.4. In the hypotheses section (Section 3) I continue the discussion about effects of overconfidence and try to rationalize further its influences over longer evaluation periods.

Previously I discussed some rationale that may be applied to overconfidence with varying investment evaluation periods because it is important from the perspective of my study, but there are many other implications of overconfidence throughout economic papers. List (2004) conducts series of field experiments that suggest that such factors as age and social preferences have a significant impact on decision making. This seems quite natural, because the notion that older individuals have different preferences than their younger peers can be considered as obvious. However, here we can create a generalizing link and state that not only market experience influences individuals' decision making and overconfidence but also the overall "life-experience", including age, gender, occupation etc. This means that overconfidence is only one factor among many influencing decision making. Despite this argument, the specific features and impacts of overconfidence should not be neglected, because this phenomenon is present not only in trading decisions but on various levels within the economic system. One of the interesting topics related to overconfidence is its impact on corporate governance. Malmendier and Tate (2005) discuss how overconfident CEOs can not be affected by incentives created by stocks and options. This means that the mechanisms of the whole corporate governance structures can be influenced by the presence of overconfidence. Venture capitalists also have a tendency to be overconfident despite their experience, as shown by results in the study by Parhankangas and Hellström (2007). They find that more pronounced risk perceptions did not reduce risk taking as suggested by the prospect theory. This finding is controversial to findings in the study by Dittrich, Güth and Maciejovsky (2005), who find that overconfidence is reduced with increased risk perception. The key difference is in the settings of these two studies, as the first one concerns risk taking preferences and the second one the certainty of possessed information. From this we can draw that overconfidence reflected as an optimistic view on the future could be different from overconfidence reflected as certainty of ones own information. At this point we can make a distinction between wishful thinking and overconfidence. I stated earlier that overconfidence is defined as miscalibration of probabilities of certain events based on some particular possessed information, but I don't want this definition to be confused with miscalibration of probabilities of future events. Individuals may believe that they know what will happen in the future because they have superior information and can make better predictions, or they can simply wish for some particular future outcome which they are not able to influence or predict. We can define the difference as misconception of factors of possessed information in the first case (overconfidence) and misconception of probabilities of future outcomes in the latter case (wishful thinking). In other words, an individual may be hoping to get a certain outcome and thus see it as more probable one. On the other hand, when this individual considers available decisions, he may see one decision as better than other based on presumed importance of a certain factor, although this factor could not be important from the perspective of statistics. Behaviour of individuals resulting from both of these biased logics can be observed as "overconfident" behaviour despite that the cognitive process could be somewhat different. For example, in both cases individuals are prone to take higher risks as they believe that a particular outcome is more likely because it is a desired outcome, or that they possess superior information which allows them to better predict this outcome. The abovementioned distinction is important, because in my analysis I use the term overconfidence mainly as a reference to miscalibration of probabilities based on possessed information rather than only miscalibration of probabilities, which was discussed in the prospect theory Section 2.3 (Figure 2). In his study, Cheng (2007) confirms that overconfidence has a negative impact on trading performance, but more importantly he studies overconfidence from several perspectives, such as: miscalibration, better than average effect, risk attitudes and market overconfidence. Here I want to point out again, that overconfidence is a multidimensional phenomenon and thus should be viewed from different perspectives.

2.7 Gender differences and market experience

This section discusses mainly effects of gender differences and market experience on the behaviour and decision making of individuals. There are numerous studies on these topics and I try to highlight main findings and theories involved. Earlier I addressed the topic of overconfidence and in this section I will also try to establish and define some relationships between overconfidence, gender and market experience. These assumed relationships serve as a base for my experimental design and further analysis.

2.7.1 Does gender matter?

Usually discussing differences in performance of males and females has been a sensitive topic. This might be because it often relates to boosting one gender's superiority in some areas or fields and people are extremely sensitive about their characteristics that have been predetermined by nature and which they can not change. However, the nature of this topic does not remove the fact that there are differences between performance of different genders and the topic has been widely studied. The statement that there are differences in performance of genders does not mean that one gender performs better than another but rather that there are certain characteristics that are more typical for males or females and those are reflected in their actions. Olsen and Cox (2001), who study market professionals, suggest that even with equal experience and expertise, women have a tendency to tolerate less risk than their men peers. The difference becomes more apparent when the decisions to be made are related to assets with more extreme properties. Main implication of these findings could be that investment recommendations given by males or females may differ to great extent especially if they involve a mixture of assets with different risk levels. In their paper, Niederle and Vesterlund (2007) conduct a laboratory experiment where individuals are given certain tasks to complete. Their main findings indicate that although there were no significant differences in the performance of males and females, first ones chose the competitive setting twice as much compared to latter ones. An important feature of the experimental setting in their study was the self-selection property i.e. subjects were free to choose what scheme to participate in. According to these results, the performance of males and females is not related to their ability to accomplish tasks but rather to their willingness to compete with others. In other words, males are more overconfident than males. The pilot study by Fryer, Levitt and List (2008) discusses the response of genders to financial incentives and how males are more likely to be motivated by those incentives. From the perspective of my study this is an interesting topic because I use financial incentives to try to bolster my results (I will further discuss the influence of different incentives in the section 2.6). As I mentioned while discussing overconfidence in earlier sections, theoretical models suggest that overconfident investors trade more. Barber and Odean (2001) study gender differences and find that men trade 45% more than women and as a consequence the wealth of men is reduced to greater extent than the one of women's. These findings are in line with the theory that men are more overconfident and trade more. In addition, these deviations and differences in behaviour appear to be systematic and thus rational behaviour assumed in several economic models has to be questioned. In his field experiments List (2004) confirms, among other factors, the there are notable gender differences related to attitudes and risk preferences.

2.7.2 Does market experience matter?

I already discussed some possible influences of market experience on overconfidence in the previous section and now I would like to discuss other implications of the experience effect. There are many studies that demonstrate the significance of the impact of market experience on various factors. For example, the study by List (2003) shows that experience can remove the endowment effect (see section 2.6.5), thus removing an important market anomaly. However, an interesting result observed in the paper by Beckmann and Menkhoff (2008), shows that market experience did not remove gender differences and market professionals exhibited reduced, but similar gender related tendencies as their student peers. Also Kaustia, Alho and Puttonen (2008) show that market experience reduces anchoring effect (see section 2.6.5) but did not remove it. Market experience could also intensify certain anomalies, as in the experiment by Haigh and List (2005), results suggest that myopic loss aversion can be observed to a greater extent among professionals than students. Taking these findings into account, we may conclude that market experience has different effect on different market anomalies and does not necessarily remove or reduce them. This conclusion is also related to the controversial results on how market experience influences overconfidence (e.g. Gervais and Odean, 2001; Allen and Evans, 2005). At this point I must note that many findings mentioned above are obtained from experimental studies and thus they can not be directly compared to each other. Results may often depend on the experimental settings and this fact can not be neglected when interpreting these results. To summarize, we can say that market experience does matter, but whether it reduces or increases market anomalies depends on various factors and problem settings.

2.7.3 Linking overconfidence, gender differences and market experience

After covering the concepts of overconfidence, gender differences and market experience, I would like to summarize these factors to establish possible relationships between them. The theoretical link between overconfidence and frequency of trading, supported by several studies, is that overconfident individuals trade more. There are also results suggesting that males are more overconfident and thus trade more than females. In addition, it has been shown that market experience does not remove differences between genders and its impact on overconfidence is controversial. From these findings we can hypothesize, that overconfidence results in more frequent trading and thus females will trade less aggressively than males. We can also hypothesize, that with increased market experience differences between gender specific tendencies and overconfidence levels are likely to be reduced. Again, these hypothetical links are based on previous findings and, as noted in the discussion on overconfidence (Section 2.6), must not be taken for granted. There are numerous factors that are hard to implement in experimental models, such as personal reasons for which investors are investing in the first place (Sevdalis and Harvey, 2007). These reasons may influence directly criteria which are included in the decision making process and thus do matter, at least from the perspective of a single individual. The question whether these personal reasons result in systematic biases remains somewhat open and would provide an interesting topic for further economic researches.

2.8 Other important behavioural biases

In this section I briefly present some of the most important behavioural biases that have been observed also in the financial markets. Because of that, I see them as an essential part when it comes to analyzing decision making in an asset allocation setting. These biases might be closely interrelated among each other and I hypothesize, based on previous studies, that some of them might lead to systematic behavioural tendencies of my subject groups. I also present several biases that may affect my own judgment and thus unbiasedness of my results and conclusions. I take this factor into account in my analysis and try to avoid falling subject to these biases.

2.8.1 Confirmation bias

People tend to search for information that would confirm their beliefs or findings and neglect information that speaks against those. In a research process one might fall subject to the confirmation bias if he finds only slight confirmation of the initial hypothesis and then tries to increase robustness of his results by highlighting only confirming evidence. We can generalize this bias and describe it as a desire of individuals to be always right and, as a result, to subconsciously search only for evidence that they actually are right instead of unbiased analysis of all available evidence. Confirmation bias may lead to neglecting relevant information in a decision making process and thus to wrong or biased decisions.

2.8.2 Framing

To describe the framing effect I use another example from previous studies: A new disease has spread and it is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of programs are as follows:

If Program A is adopted, 200 people will be saved

If Program B is adopted, there is a one-third probability that 600 people will be saved and a two-thirds probability that no people will be saved.

Subjects were asked to choose which of the two alternative programs should be adopted. Majority of respondents chose to adapt program A. After this a new group of subjects was presented with a similar problem but the context of choices was somewhat different:

If Program A is adopted, 400 people will die

If Program B is adopted, there is a one-third probability that nobody will die and a two-thirds probability that 600 people will die

Now the majority of respondents chose program B to be adapted. This example demonstrates how the way of how things are presented affects perceptions and through them the actual decision making. Framing effect can be observed in everyday life and is based on the availability of information. As in the previous example, the first case was about saving 200 people with program A and so the saving percept is more available in subjects' mind. On the other hand, when the option is turned the other way around and there are 400 deaths resulting from program A, the percept of "killing" 400 people is more available and thus intuitively avoided. To some extent we can compare this behaviour to risk-aversion in the domain of gains and risk- seeking in the domain of losses discussed in the previous sections. From this we can see how framing can induce one or another decision in a situation which is otherwise basically unchanged. I can also note that framing might be used to artificially influence individuals' choices. For example, in the financial industry, an uninformed investor might neglect the term "volatility" and accept the investment proposal but if the same proposal contains the term "risk" instead this particular investor might reconsider her decision.

Above I presented only few specific examples of framing but it is important that I try to generalize this issue. Framing can be considered as a necessary subconscious tool that enables us to understand the world and what is happening around us. In other words, framing creates interpretations of our observations e.g. objects and events. Depending on those interpretations these observations are given certain meanings and functions in our mind. Again, how deep these functions affect our perceptions depends on the narrowness/broadness of framing. In this sense, framing is an essential part of all cognitive processes. As shown in the earlier section about myopic loss aversion, the concept of framing might serve as a base for deriving answers for seemingly purely economic problems.

2.8.3 Anchoring

What would you answer if asked about yearly returns of the U.S. government bonds in 1980? If you have no idea what those returns might have been you would be likely to name a value that came from some other return values you remember. Again, if you were asked the same question but in addition told that the return on Japanese government bonds was 3% in the 1980, this value would give you a certain hint or anchor which tells you approximate magnitude of bond returns at that time but in different country. Anchoring effect is related to a tendency to make estimations and decisions relying heavily on a piece of information that is available at that time. One feature of this bias is that the "anchor" value does not necessarily have anything to do with the value an individual is trying to estimate. In other words, individuals may anchor to information that has no effect on the quality of the decision they are trying to make. The importance of anchoring effect should not be underestimated as it has a direct impact on the decision making process. The study by Kaustia, Alho and Puttonen (2008) supports the hypothesis that the anchoring effect is reduced but not removed by market experience and thus even market professionals fall subject to this bias.

2.8.4 Gambler's fallacy

Probably the most observed and studied bias is the gambler's fallacy, which implies that people assume that there is a higher probability of positive outcome if series of previous outcomes have been negative and vice versa. A typical example of gambler's fallacy can be demonstrated with coin flips. If a person who is subject to gambler's fallacy flips a coin 9 times and receives 9 tails, he would believe that receiving heads on the 10th flip is more likely than 50% due to previous 9 tails. Obviously, the probability of receiving heads, if it is a fair coin, is always ½ and previous flips should not be taken into account. The trick here is not to consider coin flips as series but as separate events. Indeed, if someone would consider the probability of flipping tails 10 times such series of events would seem very unlikely. However, when previous outcomes are known they should not be taken into account when estimating a single future event but individuals seem to neglect this fact. In later sections I return to this seemingly obvious bias and try to discuss how gambler's fallacy might actually not be a fallacy with longer event series in real-life situations.

2.8.5 Misconception of chance and sample size

People often comprehend random events too narrowly and expect random fluctuations to cancel each other out sooner than it could be predicted statistically. In other words, one would estimate that from 10 coin flips approximately 5 would be heads with higher certainty that it could be predicted by statistics. Misconception of chance is related to individuals' underestimation of randomness of series of events. We can logically link this to the gambler's fallacy and generalize the anomaly by stating that people believe that probability of events depends on the distance from the status quo or the initial reference point. However, as we will see when discussing "regression toward the mean" effect in later sections, some individual events can be seen as pulled toward certain outcomes. Misconception of chance is directly related to the underestimation of sample size i.e. wrong perception that certain events would occur according to some theory even if the sample size is too small for that to be true. In addition, if events suddenly do not behave "randomly" as determined by an individual, this individual may fall subject to clustering illusion, which means that one starts to see patterns and relationships when actually there are none. This effect can be also linked to illusion of control, which implies that individuals believe that they can influence some events although they cannot.

2.8.6 Ludic fallacy

In a nut shell, ludic fallacy refers to the low reliability of results that are derived from models trying to simulate real-life events with simplified game settings. Indeed, it is very hard or impossible to construct an experiment that takes all important factors into account. In addition, it requires that the researcher himself would recognise all the factors influencing outcomes. As mentioned in previous sections, there has been a lot of critique toward some findings and models, from which those results are obtained. However, this does not mean that experimental results are completely meaningless but rather that they might be artificially bolstered or diminished. On the other hand, even if experimental results are not directly applicable to real-life situations, they often reveal important relative differences between treatment groups. Contrary to the subjective experimental measures, relative differences may very well apply in the real-life as they are not necessarily dependant on the experimental settings. It is clear however, that real-life can not be simulated precisely but only approximated and modelled with vast amount of simplifications. Despite robustness of the results and findings, it is important to remember, that stated rules are constantly broken and one can not rely blindly on the predictions of the model or analysis. As an example, I would like to refer to earlier described gambler's fallacy and how people tend to take past outcomes into account when making future estimations although they should not. I also mentioned that this fallacy may well not be a fallacy at all if taken to the real-life situation. Imagine that you have flipped a coin for a hundred times and all the outcomes were heads. Now you are trying to guess, what is the probability of getting tails on the 101st flip. According to the theory, probability of getting tails is exactly ½, but would you bet your money on this? The factor that is not taken into account by this basic model is that the coin is not necessarily fair and so results could be also biased. Similarly, we can apply this logic to almost any event in real-life because it is very seldom that we manage to see and understand everything that is relevant for optimal decision making. From this perspective we may question whether individuals are rational when they seem to fall subject to certain biases and are they irrational when they try to avoid them.

The purpose of this study is not to state philosophic views but to try to find new aspects to behavioural issues in the field of financial decisions. Never the less, ludic fallacy is obviously present in my experimental setting and I recognise that results obtained from my model might not hold in the real markets. However, my findings will shed light on different relationships between economic actors and their asset allocation preferences and through that contribute to the existing economic literature.

2.9 Asset allocation decisions

As my study is related mainly to myopic loss aversion in the asset allocation environment, I want to discuss how asset allocation choices are made before going to hypotheses and experimental design. Because the topic concerning optimal asset allocations is complex and reaches far beyond the scope of my study, I only discuss basic starting points which I see as the most relevant from the perspective of my research problem. I also present arguments that suggest psychological aspects playing a significant role in the asset allocation process along with reasoning and mathematical models. First, I discuss the very basics behind optimal asset allocation and describe a mathematical model involving logarithmic utility approach and volatility pumping. After that, I discuss implications for prospect theory in asset allocation settings and introduce a hypothetical model involving two mental accounts.

2.9.1 Optimal asset allocation

The starting point behind optimal asset allocation is to diversify your portfolio so that it corresponds to your specific risk preferences and return appetites. Assuming that there is no free lunch i.e. arbitrage opportunities, high risk involves high potential returns and vice versa. An investor then chooses a combination of assets which bring certain return at a certain risk or uncertainty. This principle sounds fairly simple and mathematical models can be constructed to try to estimate optimal asset allocations with predetermined risk tolerance and stochastic returns. Even so, it would seem too trivial to assume that investors rely purely on predictions of these models, even if their estimates were good enough, and would neglect their intuition. As discussed in previous sections, this is hardly the case in practice and psychological aspects can create systematic behavioural tendencies that lead to market anomalies. Let us consider a case of utilization of technical analyses. Technical analyses are provided to predict short-term future outcomes of, say, foreign exchange rates (FX-rates). These analyses are based purely on past data, which according to the conventional financial theory should have nothing to do with future forecasts. Despite this, vast majority of traders implement technical analyses in their estimates and these estimates often turn to be surprisingly accurate i.e. the FX-rates often turn to be within forecasted limits. The question is whether this was so if only the minority of traders actually believed in the practical usability of technical analyses and the system would not feed itself. In this case, optimal asset allocation would involve following the direction forecasted by technical analysis, because it is believed that everyone else would do so, eventually making the forecasted directions to take place. This is only one simple case involving a single instrument but it demonstrates how decisions, that otherwise would seem irrational, become rational when we take into consideration expectations about behaviour of other agents in the system. But what if this behaviour takes us into direction that breaks the link between the system and the actual instruments which this system is supposed to control? As examples, we can remember events such as breaking from the gold standard and defaults caused by sub-prime mortgages. Here we can argue that markets are at most minimally rational i.e. not fully rational and thus optimal asset allocations for investors should include minimal rationality principles, because standing against the majority could only damage ones wealth. However, this is not necessarily a problem for particular individuals but rather for the whole society as there are severe consequences if everybody herds in the wrong direction. What comes to choosing optimal combination of multiple assets involving different returns and risks it is hard to believe that such choices are based purely on these two criteria.

It is important to consider optimal asset allocation not just as an initial decision but as a chain of decisions that are made during the whole investment period. It is this decision chain that may reveal behavioural biases and influence final wealth of an investor. However, it is also important to understand how initial investment decisions are made and whether they can predict further course of actions.

2.9.2 Logarithmic utility approach

To introduce the logarithmic utility approach we can first define the objective function of an investor. Consider a bet that brings 3 times the invested amount or nothing with equal probabilities of 0.5. The expected outcome from a single bet (A = all assets) is thus $0.5 \times 3 \times A + 0.5 \times 0 \times A = 1.5 \times A$, which is clearly positive. Now let us think of a sequence of similar bets and try to define an optimal betting strategy. As noted above, the expected value of a single bet is positive and it would seem that betting all money (A_t) every time would bring the highest final wealth. However, this strategy would probably result in getting bankrupt at some stage and ending up with no money to bet. We can define the portion of A, which we would bet, as x ($0 \leq x \leq 1$). The final wealth from a favourable outcome from a single bet would be $A \times (1-x) + A \times 3x$, and similarly $A \times (1-x)$ if an unfavourable outcome occurs. Thus if we bet 50€ of our 100€, the final wealth would be 200€ (growth factor = 2) in the favourable case and only 50€ (growth factor = ½) in the unfavourable case. If we continue betting, the amount of favourable and unfavourable outcomes can be expected to be approximately the same because the probabilities are of equal magnitude. From this, we can conclude that the average growth factor for betting half of our money every round would be approximately 1 i.e. multiplication of 2 and 0.5. On the other hand, if we bet ¼ of our money every time, the growth factor for two bets would be on average $\frac{3}{2} \times \frac{3}{4} = \frac{9}{8}$. This is because favourable outcome brings a growth rate of

$1-\frac{1}{4}+\frac{3}{4}=\frac{3}{2}$ and unfavourable one $1-\frac{1}{4}=\frac{3}{4}$. Now we can define the growth factor for our bets as $\sqrt{\frac{9}{8}} \approx 1.061$, which is better than 1. If we apply this logic we can determine an optimal asset allocation strategy of an investor as the maximization of the total growth rate g for her investment. In the logarithmic utility approach we consider the final wealth A_n as a series $A_n = A_0 r_1 r_2 ... r_{n-1} r_n$, where r is a growth rate at each period (in the previous example r was either 2 or 0.5 with 50% probabilities) and n is the number of these periods. It can be shown that implying the law of large numbers these series can be written as:

$A_n \to A_0 e^{gn}$ where $\ln\left(\frac{A_n}{A_0}\right)^{\frac{1}{n}} \to g$ and $g = E(\ln r_1)$ (3)

This function means that with n periods (when $n \to \infty$ is large) the investment grows exponentially at a rate g. In other words, an investor has to choose and rebalance his investment portions so that growth factor g is maximized.

The following example demonstrates the concept of volatility pumping implementing the logarithmic utility approach.

Consider two available assets:

Asset 1: Return for one period: +100% with 0.5 probability or -50% with 0.5 probability

Asset 2: Return for one period: +0% with 1 probability

If you invest all of your money in one of those assets, the returns should not be very attractive, because Asset 1 has a high volatility but its long-term growth rate is nonexistent and Asset 2 has no growth rate at all. However, investing ½ of your money in each asset and rebalance your investment after each period should provide much better results. If we look at a single period, a ½ investment in both assets would bring $\frac{1}{2}+\frac{1}{2}\times 2=\frac{3}{2}$ in the favourable case and $\frac{1}{2}+\frac{1}{4}=\frac{3}{4}$ in the unfavourable one. We can then calculate the long-term expected growth rate g utilizing logarithmic utility: $g = 0.5\times\ln\frac{3}{2} + 0.5\times\ln\frac{3}{4} \approx 0.06$. This means that your investment will grow approximately as $A_0 e^{0.06}$ giving you a long-term return around 6%. This return is achieved because some of the money from favourable outcomes of Asset 1 are invested in Asset 2 for the next period and if an unfavourable outcome occurs, funds are rebalanced from Asset 2 to Asset 1. The key aspect of this strategy is that at the beginning of each investment period the portions invested in risky and risk free assets are rebalanced correspondingly to their initial fractions.

The abovementioned example is greatly simplified as there are only two assets and no transaction and other costs. However, we can already see that even accessing solutions for this simplified model takes plenty of time and theoretical reasoning. In more complex cases, not even mentioning real-life situations, accessing optimal decisions could be very tedious and long process and at the end some important factors could be still missing from the model. Taking this into account, it could be argued that people would tend to trust their intuition to avoid this tedious work to save time and make investment decisions accordingly (see section 2.1, Cognitive process of decision making). This does not mean that people would constantly fail to choose a suitable investment strategy, say 50/50 as in the previous case, but the reasoning behind that could be rather different from the discussed mathematical approach.

2.9.3 Prospect theory and optimal asset allocation

As previous mathematical model does not include behavioural factors, we can try to implement the prospect theory to see whether it can explain some features of decision making process in the asset allocation setting. To do so we will look at the value function presented in Figure 1. As stated earlier, we are interested how the initial investment decisions are made before going to the consequent decisions and thus we can first consider only the initial prospects for a single period (this assumption involves various simplifications such as narrow framing of choices etc.). Let us consider a similar example as in the previous section i.e. two available assets, one of which (Asset 1) doubles the investment with ½ probability and halves the investment with ½ probability; the other asset (Asset 2) is just a deposit account with no return and no volatility. An individual has then to choose a suitable strategy concerning available prospects taken into account the initial reference point. If the initial capital is A_0 ($A_0 = 100€$) we can assume that also the reference point is set at A_0. Now the available prospects for a single period depend on the portions invested in Assets 1 and 2. Let us assume that this particular individual values losses more than gains as determined by λ ($\lambda = 2$). For the simplicity reasons we can neglect the misconception of probabilities determined by w (shown in Figure 2) and consider presumed probabilities of gains and losses equal to the actual probabilities i.e. $p_1 = p_2 = 0.5$. Because only Asset 1 involves any uncertainty we can determine gains (G_1) and losses (L_1) for the available prospects after a single period:

$$G_1 = A_0 x(w_1 - 1); w_1 \geq 1 \tag{4}$$

$$L_1 = A_0 x(w_2 - 1)\lambda; w_2 \leq 1 \tag{5}$$

where x ($0 \leq x \leq 1$) is the fraction invested in Asset 1 from the initial capital and w_1, w_2 are the growth factors by which the money invested in Asset 1 is multiplied ($w_1 = 2, w_2 = 0.5$). From this we can construct a simplified function representing the expected utility from available prospects for a single period:

$$E(U_1) = A_0(1-x) + A_0 x + p_1(w_1 - 1)A_0 x + p_2(w_2 - 1)A_0 x\lambda \text{, or simply}$$

$$E(U_1) = A_0 + p_1 G_1 + p_2 L_1 \tag{6}$$

where $A_0(1-x)$ is the utility from investing in Asset 2, $A_0 x$ is the investment in Asset 1 and $p_1(w_1 - 1)A_0 x + p_2(w_2 - 1)A_0 x\lambda$ is the expected utility from gains and losses of investment in Asset 1. Thus if we invest 50€ from our initial money (100€) into Asset 1, implying that our $\lambda = 2$, we would get $E(U_1) = 100€$, which is exactly our initial wealth. It is easy to see, that if this logic holds and the reference point is the initial wealth $A_0 = 100€$, the optimal x depends on our loss aversion λ and thus optimal $x = 1$ if $\lambda < 2$ and $x = 0$ if $\lambda > 2$. With $\lambda = 2$ we should be quite indifferent towards the magnitude of x. In other words, an individual who is more sensitive to losses and has $\lambda > 2$, will always be better off if he keeps all his money on the deposit account (Asset 2) as his combined expected utility $E(U_1)$ would be always less than the initial capital A_0. Opposite applies if an individual has $\lambda < 2$ i.e. all money should be invested in Asset1 because it always brings $E(U_1) > A_0$. Figure 3 demonstrates this rationale with a simplified value function.

If we assume coefficient of loss aversion λ to be the main driver behind preferred asset allocation and reference point to be the initial wealth or money amount available for investment, we can also assume that the subjective optimal allocation would be achieved at extreme values of x i.e. $x = 1$ or $x = 0$. From the Figure 3 we can see that the point (r_1, u_2) will be preferred to all points on the line ($r_1, u_2; r_0 u_0$) if $\lambda < 2$ and point ($r_0 u_0$) will be preferred to all points on the line ($r_1, u_3; r_0 u_0$) if $\lambda > 2$. This is because we assumed that the utility of prospects is estimated as in the Equation 6 where changing λ above and below critical value of 2 results in extreme changes in preferences. However, this statement is contrary to the intuitive reasoning which implies the invested amount should be divided between Asset 1 and Asset 2 to correspond to the risk and return tolerances of a specific individual. No doubt, this is only a simplified example with only a single period and known probabilities, but by presenting it I wanted to show that asset allocation choices even for a single period are hardly to be determined purely by loss aversion factor as presented in the example in section 2.4. I would argue that even when only a single period is involved i.e. no rebalancing in between, individuals will think of possible gains and possible losses if they consider portion invested risky asset as well as lost gains and saved losses when considering a risk free choice. For example, let's take the following case:

1. *Individuals are told that they have initially 100€ and are asked if they would accept an investment that requires 100€ and returns either 200€ with 0.5 probability or 50€ with 0.5 probability.*
2. *The same individuals would then be asked how much money from their initial 100€ they would place in an investment that returns either 2 times the money placed with 0.5 probability and 0.5 times the money placed with 0.5 probability.*

I hypothesize that individuals who accepted the gamble in the first case would invest less than 100€ in the second case and individuals who rejected the investment in the first case would invest more than 0€ in the second case. This may seem obvious, but theoretically it is not so straightforward why loss aversion would diminish when relative potential loss gets smaller. Clearly, if your initial wealth is 100€, the prospects of loosing 50€ or winning 100€ (1) and loosing 5€ or winning 10€ (2) can not be considered as equal, because of the large difference in marginal changes. This rises a question about how individual make asset allocation choices for a single period when their reference point is not yet shifted to the domain of losses or gains.

2.9.4 Are avoided losses considered as gains? Double mental account approach

The idea behind double mental account is that individuals consider potential gains and losses (commission account) along with potentially lost gains and saved losses (omission account). This idea is closely linked to the concepts of regret of commission i.e. regret of doing something and enduring losses, and regret of omission i.e. regret of not taking action and losing potential gains. I use the concept of dual mental account to explain why some empirical results may not fully support the prospect theory explanation of the disposition effect.

Even though I hypothesize that there is a reaction to lost potential gains, this does not mean that this reaction should be equally potent as the reaction to actual losses. In other words, reaction to "not getting something" can not be similar to "loosing something". In the double mental account approach I assume that individuals consider two mental accounts, one of which reflects preferences towards gains and losses (commission account) and the other one that reflects preferences towards lost gains and saved losses (omission account). An individual will then consider utilities from prospects of these accounts to find a suitable combination of risk and return. In a simple form, considering previously discussed example with two assets (Asset 1 and Asset 2) and Equation 6, this concept can be written as follows:

(1) commission account

$$E(U_C) = A_0 + p_1(w_1 - 1)A_0 x\lambda_{CG} + p_2(w_2 - 1)A_0 x\lambda_{CL} \quad (7)$$

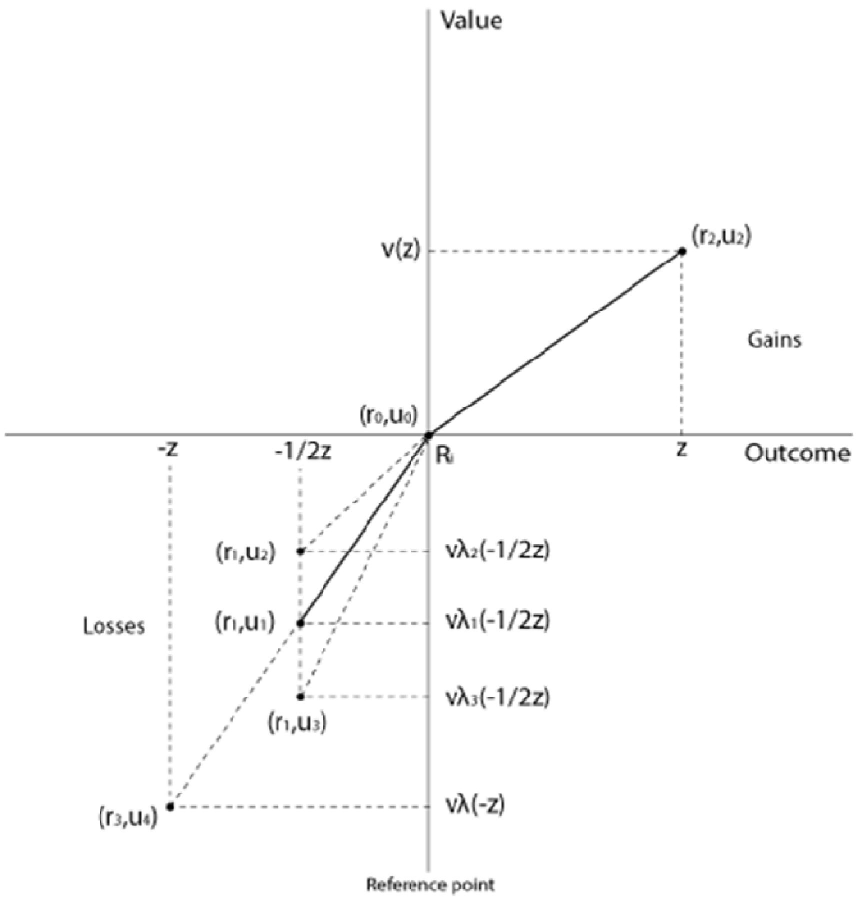
(2) omission account

$$E(U_O) = A_0 + p_2(1 - w_2)(1 - x)A_0\lambda_{OG} + p_1(1 - w_1)(1 - x)A_0\lambda_{OL} \quad (8)$$

where $\lambda_{CG}, \lambda_{CL}, \lambda_{OG}, \lambda_{OL}$ are individual specific relative weights assigned to gains, losses, saved losses and lost gains respectively. The magnitudes of λ_{CL} and λ_{OG} are assumed to be driven by factors such as loss aversion and uncertainty effect and the magnitudes of λ_{CG} and λ_{OL} are assumed to be driven by factors including overconfidence and greed. From Equations 7 and 8 we can see that individuals receive higher presumed utility from commission account when their loss aversion (λ_{CL}) is low, but on the other hand, presumed utility from omission account gets higher with higher λ_{OG} i.e. higher utility from saved losses. For simplicity we can scale utility weighting factors so that $\lambda_{CG} = 1$. λ_{OL} is also considered to be greater than λ_{OG} based on the assumption that on the omission account greed and overconfidence overweight uncertainty and loss aversion similarly as loss aversion overweighs λ_{CG} on the commission account. In addition, I assume that relation $\lambda_{CG} / \lambda_{CL}$ is not necessarily the same as $\lambda_{OG} / \lambda_{OL}$, because different mental account is involved with different perception of the problem and different accessibility.

In the double mental account approach an individual tries to maximize combined utility from his commission and omission accounts according to different preference and aversion factors. However, to justify this approach, I have to assume that an individual has experienced losses and gains as well as lost gains and saved losses from similar asset allocation problems. Otherwise, it would be hard to believe that one can easily access information about past experiences concerning specific investment outcomes and thus access commission and omission accounts due to effect of ease of recall. Despite this, it can be suggested that one could easily substitute perception of potential losses in the initial investment or gambling situation by, say, experience from diminishing wealth when paying taxes or interest on late bills. I make this statement because I believe that there are in general much more events that involve giving up money, e.g. everyday payments, than events involving missing a chance of getting money and actually realizing that there was a miss. From this, I argue that initially commission account is more easily accessible than omission account, because experiences of looses are more accessible or substitutable than experiences of missed gains. This state will change if an individual constantly misses gains or saves losses due to high loss aversion and omission account becomes more accessible in one's mind. If this logic holds, omission account of highly loss-averse individuals will become more salient and thus will have more influence on their following decisions. As discussed in the prospect theory section, risk taking preferences of individuals are reduced when they move further in the domain of gains i.e. the value function is concave, and increased when they fall deeper in the domain of losses i.e. the value function is convex. This aspect of the prospect theory was proposed as an explanation to the disposition effect as it implies that investors will secure gains when they occur reducing portfolio risk, and try to compensate for losses by holding losers, maintaining or increasing portfolio risk. However, some empirical results suggest that the prospect theory can not fully explain this effect (Kaustia, 2008) and propensities to sell stocks remain approximately constant with increasing gains or losses.

Figure 3: Loss aversion in the prospect theory



This figure illustrates a single time period prospect with changing loss aversion coefficient. The choice depends largely on the magnitude of the loss aversion of a particular individual. However, there is no general rule concerning the magnitudes of gains and losses involved and thus prospect evaluation depends on the initial wealth and time horizon.

From abovementioned rationales and findings, I would propose the double mental account as one possible theory to consider when assessing the disposition effect and explaining why propensities to sell would not drop or increase substantially when outcomes move further into domains of losses or gains. Consider a simple example where an investor has experienced the following outcomes from investments in Asset 1 (p=0.5, 2 x investment or p=0.5, 0.5 x investment) and Asset 2 (p=1, 1 x investment). For simplification, let us assume that $\lambda_{CG} / \lambda_{CL} = \lambda_{OG} / \lambda_{OL}$, where $\lambda_{CG} = 1$ and λ_{CL} of this particular investor is 2:

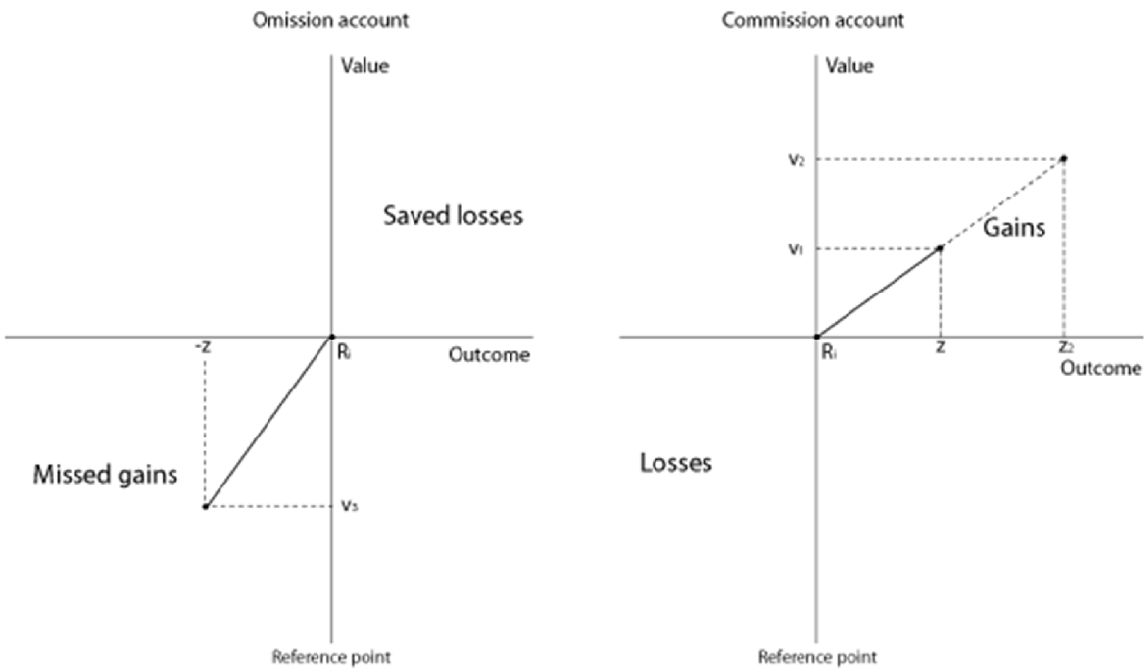
Initial capital available for investment: 1000€

Initial Investment in Asset 1: 500€, and in Asset 2: 500€

Outcome for Asset 1 for the first period is positive: 2 x 500€ = 1000€

An investor has now moved to the domain of gains and plans an investment strategy for the next period. According to the value function of the prospect theory, an investor would now tend to reduce his investment in Asset 1 to reduce overall portfolio risk, because additional positive utility from gains is now smaller than the negative utility from losses due to value function concavity (see Figure 1). However, if we use a double mental account approach, we can see that despite gaining additional 500€ to his initial capital, an investor has also lost potential 500€ because he invested 500€ in the risk-free Asset 2. This simplified situation is demonstrated in Figure 4, which displays commission and omission accounts for one period. Because of the endured losses on the omission account, an investor will take this experience into consideration in the new investment decision. The signals from two mental accounts are now different: commission account signal suggests a reduction of investment in Asset 1 to secure gains, but omission account signal suggests an increase of investment in Asset 1 to compensate for lost potential gains. In combination, these signals result in smaller tendency to reduce investment in Asset 1 compared to the one suggested by the prospect theory value function. In other words, I hypothesize that the controversial results related to the disposition effect may be partially due to the mental accounting that makes investors consider previously available but not realized outcomes in their following asset allocation decisions.

Figure 4: Example of omission and commission accounts



This figure illustrates how omission and commission accounts work in the case of gains from a single period. This concept assumes that there is an initial sum available for investment and that this sum is distributed between safe and risky investments. Commission account displays utility from occurred gains and omission account displays negative utility from missed gains which are due to safer investments.

Double mental account approach may be thought of in form of two value functions, which are sketched in Figure 5. To what extent mental accounts are taken into consideration depends largely on the individual specific characteristics such as risk aversion, overconfidence and greed. Value function of the omission account is assumed to be more flat than the one of the commission account, because I believe that real gains and losses produce more tangible and powerful experiences than hypothetical and speculative experiences from the omission account (this assumption implies that $\lambda_{CG} > \lambda_{OG}$ and $\lambda_{CL} > \lambda_{OL}$) and real experiences are also more accessible in investors' minds. In addition, we must not forget about various behavioural biases, e.g. gambler's fallacy, which may influence the weights on commission and omission accounts.

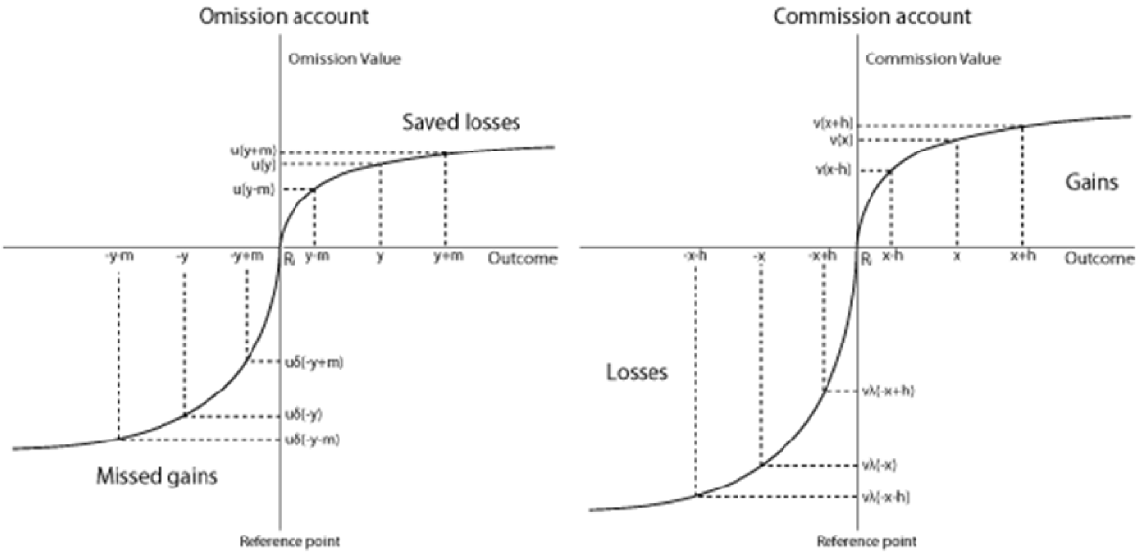
Perhaps, the most important insight in the double mental account approach is that individual's choices depend not only on the reference point of the initial wealth which is placed under uncertainty but also on the whole initial wealth available and its distribution among risky and less risky choices.

Utilizing Figure 5 I would like to show how double mental account approach may explain why propensity to sell risky assets does not increase when gains shift further from the reference point as it is predicted by the value function in the prospect theory. Let us take the following example:

> *An investor has initially 100€ available for investment. There are two possibilities: to invest in risky asset which doubles the investment or returns nothing and a safe deposit account with no return rate. She invests 50€ in the risky asset and keeps 50€ on the deposit account. This investment brings a positive outcome and investor shifts into domain of gains with the return on investment of x = 50€ times 2 = 100€.*

Now it is time to consider how much to invest for the next period. According to the value function of the commission account, value $v(x+h) - v(x)$ from additional gains $+h$ is less than value $v(x) - v(x-h)$ from equal losses of $-h$ and thus the investor should secure gains and reduce her investment in the risky asset. However, if we take into account that our investor has lost 50€ of potential gains (50€ times 2 minus 50€), value function of the omission account suggests that value $u\delta(-y+m) - u\delta(-y)$ from compensating for lost potential gains with $+m$ is greater than value $u\delta(-y) - u\delta(-y-m)$ from saving losses if there is an unfavourable outcome with $–m$. As noted earlier, omission account is now in the domain of lost gains $(-y)$ and commission account in the domain of gains $(+x)$, because the first period outcome was positive. Taking this into account we may consider the following rationale concerning the second and following investment periods: An investor would like to secure gains from the first period by reducing investment in the risky asset, however, at the same time there an incentive to compensate for lost potential gains from the first period.

Figure 5: Omission and commission value functions



This figure sketches the possible forms of omission and commission value functions of an individual. These functions are related to the double mental account approach and represent the relationship between gains and losses and saved losses and missed gains. It is assumed that the omission account becomes more salient with higher missed gains and saved losses.

Depending on the weights assigned to commission and omission accounts an investor will keep more money in the risky assets for the second period than suggested purely by prospect theory value function. One possible scenario could be that investor specific weights of omission and commission accounts are assigned so that the fraction of total wealth invested in risky asset stays the same. In other words, chosen prospects in the omission account value function are equal to chosen prospects in the commission account value function i.e. $|u\delta(-y+m) - u\delta(-y)| - |u\delta(-y) - u\delta(-y-m)| = |v(x) - v(x-h)| - |v(x+h) - v(x)|$. From this equality an investor decides how much money to keep in the risky asset for the second period. Now let us assume that the outcome for the second period is positive and risky asset returns 2 times the investment. Again, commission account moves further into domain of gains (x+h) and omission account further into domain of lost potential gains (-y-m). This results in the omission value of uδ(-y-m) and commission value v(x+h). From this situation an investor would consider omission and commission prospects for the third period. If the assumption of investor specific weights holds, the fraction invested in the risky asset for the third period should be approximately the same as for the second period i.e. an investor would like to secure gains from positive outcome but at the same time will want to compensate for lost potential gains from the second period.

According to this rationale, the propensity to sell or buy risky assets will stay approximately the same and not shift significantly depending on how far gains or losses shift from the initial reference point i.e. the initial assets available for investment. From this theory, I hypothesize that investors with higher portion of total wealth invested in risky assets will have higher tendency to disposition effect due to diminished effect of omission value.

2.10 Reinforcer types

I want to conclude theoretical Section 2 with discussion about basic principles of the experimental design described further. These principles are mainly related to the incentives provided for the game participants and thus are essential from the perspective of this experimental study. First of all, the question is how to make individuals participate in the experiment and how to make them act naturally as if they act in real-life. As discussed in the section about behavioural biases, this task is not easy and in fact quite impossible. However, there are some characteristics that one may include when designing a behavioural experiment and I will present some of those experiment characteristics.

2.10.1 Real versus hypothetical money

It important to state at the beginning, that there is no general answer to whether real rewards are better than hypothetical ones or vice versa. The main point is when and how to use different types of incentives (Dodonova and Khoroshilov, 2007). As the purpose of incentives is to get experiment participants to answer honestly and consider the problem in the same manner as in real life, these incentives should depend on the problem in question. For example, if participants are presented with asset allocation decisions, real financial incentives are a good choice because they result in a mindset that corresponds to real-life situation. On the other hand, the magnitude of these financial incentives could be a crucial factor because too low real rewards may trigger an opposite reaction that was intended i.e. lower commitment and less effort. In experimental settings which are related more to psychological decisions, hypothetical rewards may work very well and no real rewards are necessary. There are also various incentives that may act similarly as real money e.g. Fantino, Gaitan, Kennelly and Stolarz-Fantino (2006) show that time off from a tedious task may act as a substitute for real money. However, constructing a controlled experiment with tedious tasks and voluntary participants may be difficult. This is one reason why I rely on real monetary rewards in my experiment and try to diminish the risk related to small stakes by introducing large sums of hypothetical units and option to transfer gained funds to charity.

2.10.2 Relevant subject groups and model perception

In addition to types of incentives provided for experiment subjects it is crucial to segment those subjects and select ones that are most related to the problem in question. In other words, it is important to pick participants who are making similar decisions in their everyday lives and thus have a certain mind setting for particular situations. This is mainly because the experiment results become more relevant and interesting if they are achieved by analyzing people who are actually involved in making similar decisions in real-life. The segmentation criterion also allows designing an experiment involving specific terms and definitions, with which this segment group could be expected to be familiar with. In the case of my experiment I use market professionals and economic students bearing in mind that my experiment is related to asset allocation decisions. In this way I expect that that the majority of participants will comprehend the problem correctly and thus possible biases are reduced in the sample. Another reason for using segmented subject groups is their relation to presumably similar decision situations in real life i.e. market professionals do this for living and economic students are studying the subject to become professionals. However, my main goal in the experimental design was to make it matter for the participants and to encourage them to make comprehended and reasoned decisions. Unfortunately this goal can be achieved only by testing the experimental setting and analyzing the feedback, which I also do.

3. Hypotheses

In this section I present main hypotheses and explain their theoretical backgrounds. I consider four main hypotheses, which are related to financial incentives, myopic loss aversion, overconfidence and gender differences. These hypotheses are based on previous research papers as well as behavioural theories and biases.

H1 = Financial incentives will reduce the number of myopic choices and increase portion invested in risky assets.

I hypothesize that enhancing low evaluation frequency options with sure gains can attract myopically loss-averse subjects and reduce number of myopic choices. If MLA assumptions hold, subjects will increase portion of risky bet and thus investors' risk preferences might be manipulated via financial incentives. In other words, attracting myopically loss-averse subjects to choose less frequent evaluation should have a positive effect on their bet size. In accordance with the prospect theory probability weighting function, I assume that even relatively small bonuses that are received with 100% certainty are valued more than potential returns that involve uncertainty. On the other hand, there might be a reverse effect as individuals will suspect that there is something wrong with this option, otherwise, why would there be a reward for choosing it? This effect might make people value lost evaluation and rebalancing frequency more than the provided sure gain or bonus. Again, this is only a hypothetical assumption based on human psychology. Such behaviour might reduce average magnitude of a bet in the low evaluation frequency option. In another setting, if the low evaluation is made less attractive by introducing a fee (sure loss) for choosing this option, I hypothesize that subjects will shift their choices to less myopic ones. This is based on the assumption that even the most myopically loss averse subjects will give up the option involving sure loss and rather bet on less frequent evaluation option (there is always a possibility not to bet at all i.e. 0 > sure loss). Optimal case would still be that financial incentives would not just enforce giving up more frequent evaluation but increase portion of investment in risky assets as MLA theory suggests.

H2 = More overconfident individuals are more likely to choose higher evaluation frequency.

Previous studies suggest that more overconfident individuals tend to trade more frequently and aggressively. This is because overconfident traders believe that they have better and more accurate information than others. However, in my experimental setting, overconfidence of individuals can not be logically based on previous market experience as historical performance of real-life securities does not matter and everyone has same initial information. In this case, source of overconfidence can be assumed to rise from one's trust in own luck and better understanding of the problem. Overconfident individuals believe that their intervention can influence positively their portfolio performance. As there is no fee (in the basic treatment) for rebalancing one's portfolio, subjects will choose to do so more frequently in general, but overconfident individuals are assumed to underweight probability of losses and place higher bets. As stated above, overconfidence implies that individuals believe that they have superior information about future returns. Taking this definition into account, one may argue that overconfident subjects are less interested in acquiring new information by reviewing their portfolio frequently. Contrary to this hypothetical argument, I note that overconfident individuals not only believe that they have better understanding of the initial problem, but can make better choices (compared to other participants) based on the new information from temporary outcomes. This belief would lead to choosing most frequent evaluation option. However, as discussed in Section 2.6, there can be a distinction between overconfidence arising from belief in superior information and overconfidence arising from misconception of probabilities. In my experiment all subjects are given the same initial information and the experimental setting is not closely related to any real-life investment situations i.e. you rarely invest in flipping coins. From this, I can assume that most of the overconfidence will arise from misconception of probabilities and belief in one's luck. Even so, overconfident individuals are assumed to make sure that their luck is in place by choosing to review their investment frequently.

H3 = Individuals with higher portion of total available wealth invested in risky assets will be subject to disposition effect to greater extent than individuals with lower portion invested in risky assets.

This hypothesis is based mainly on the double mental account approach which was discussed in Section 2.9.4. According to this theory, individuals with higher portion invested in risky assets will experience less effect on their omission account an thus behave more in accordance with the commission account value function, which is similar to the value function of the prospect theory. In other words, increased portion invested in risky assets will increase propensity to sell these assets when there are positive outcomes and decrease propensity to sell risky assets when there are negative outcomes. Individuals with moderate and low investment portions in risky assets will tend to maintain these portions throughout the whole investment period and thus their propensity to sell will stay approximately constant. This rationale is based on the assumption that individuals with low and moderate investments in risky assets will experience omission account effects more than individuals with more risky assets.

H4 = Female subjects will choose high evaluation frequency option more often and have lower investment portion in risky assets than male subjects.

This hypothesis is based on the assumption that female individuals are more risk-averse and less overconfident (e.g. Beckmann and Menkhoff, 2008). As discussed in Section 2.7 there are clear differences between males and females when it comes to investment decisions and recommendations. The point of interest in this hypothesis is whether females make more myopic decisions than male subjects and whether these myopic decisions lead to worse performance and lower final wealth. In other words, if women prefer to evaluate their portfolios more often than men, it could reduce their risk taking preferences even more if we compare to a single period investment decision differences. Taking into account Hypothesis H1, I m also able to compare whether men respond better to financial incentives, which could be due to their more competitive nature. On the other hand, it is also possible that males will ignore financial incentives more often than females because of their higher overconfidence.

4. Experimental design

In this section I describe aspects of my experimental setting and go through most relevant methods and expectations involved. Typically myopic loss aversion experimental designs have had fixed evaluation frequency settings and subjects were unable to choose between frequent and infrequent portfolio evaluation. In other words, as in the experimental setting of Gneezy and Potters (1997), subjects are protected from their own myopia in the infrequent evaluation treatment. My design is different in that respect and individuals are allowed to select their evaluation frequency from three different options. This allows to test whether individuals prefer more frequent evaluation even if there are other options available. From my point of view, it is important to exercise less artificial control in the experimental setting and try to control the subject group by other means. In this way subjects are not bound by the setting and thus their presumptions of the problem are more similar and their behaviour is more comparable. As my first hypothesis H1 is related to the influence of financial incentives on the portfolio reviewing frequency, I create an experimental environment where I try to control for myopic decisions by introducing rewards and fees for choosing certain options. Weber and Zuchel (2005) show, that individuals' reactions to prior gains and losses depend largely on how the experiment is framed i.e. if the experiment is framed as a lottery individuals tend to act according to the house-money effect (increase risk-taking with gains) but if the experiment is framed as an investment portfolio individuals increase risk-taking with losses and reduce risk-taking with gains. Important difference between framing the experiment as a lottery or as an investment portfolio is that in a lottery an individual has a chance to win a price of a lottery ticket plus some gain or receive nothing and in an investment portfolio an individual receives gains (equal to the gain in the lottery) or endures losses (equal to the price of the lottery ticket). I try to frame my experiment more as an investment portfolio and individuals in my experiment have equal chance to gain +30% on their investment or loose -20% of their investment in each of 12-rounds.

The essential part of my experiment is the coin flipping game where individuals are asked to place bets on flipping twelve coins. In this game participants are able to choose to flip different amount of coins simultaneously and can choose to flip coins from 4 to 12 times. This coin flipping setting simulates an investment portfolio evaluation frequency, which depends on how many coins are chosen to flip simultaneously. The concept of the coin flipping game is explained in more detail in the following sections.

4.1 Coin flipping game

Similarly to experiments in the studies by Gneezy and Potters (1997) and Haigh and List (2005), my experimental setting is aimed at determining whether reduced evaluation frequency leads to increased risk preferences. I present my experiment subjects with a chance to bet on flipping twelve coins. The game rules are as follows:

1. Game participants are initially granted 1000 game units worth 5€ (game unit exchange rate is 200 units = 1€).
2. There is a possibility to bet some or all of the available game units on flipping coins, which return values of either 1.3 or 0.8 each with equal probability.
3. Bets are multiplied by coin outcome values.
4. Individuals are able to choose to flip one, two or three coins simultaneously.
5. Game ends after all twelve coins are flipped.

The game proceeds when an individual has chosen an amount she wants to bet, the number of coins she wants to flip simultaneously (1-3) and pressed the "Flip" button. Then the coin flip outcomes are displayed including coin outcome values, game unit change to previous bet and the new unit amount available to bet. It is important from the perspective of the MLA theory to avoid showing the outcomes from intermediate steps if an infrequent reviewing is chosen. This is why only the unit change to previous bet is displayed in the game and if an individual chooses to flip three coins simultaneously he will be unable to see intermediate unit changes from flipped first and second coins. The visual appearance of the game application is illustrated in Appendices 1-3.

4.1.1 Evaluation frequency

As stated previously, coin flipping game includes a possibility to flip one, two or three coins simultaneously. From this, we can say that choosing to flip only one coin at a time results in the highest evaluation frequency, because individuals are able to rebalance their bet and there are no intermediate outcomes. Considering a myopic loss aversion example presented in Section 2.4, a flip of a single coin can be presented as a simple utility function:

$$U = wp_1 + lp_2\delta \tag{9}$$

where $w = 1.3 \times bet - bet$ and $l = 0.8 \times bet - bet$ are relative gains and losses, $p_1 = p_2 = 50\%$ are their corresponding probabilities and $\delta > 1$ (empirically around 2) is an individual specific coefficient of loss aversion. Now if we consider utility for a person betting 100 units on a single coin flip we will get $U = 30 \times 0.5 + (-20) \times 0.5 \times \delta$, which is positive with $\delta \leq 1.5$. The value off loss for this bet is then:

$$L = (-20) \times 0.5 \times \delta \tag{10}$$

In the second option (2) with two dice rolled, the similar function can be presented as:

$$U = w_1 \times 0.25 + w_2 \times 0.5 + l_1 \times 0.25 \times \delta \tag{11}$$

With 100 unit bet this function will give $U = 69 \times 0.25 + 4 \times 0.5 + (-36) \times 0.25 \times \delta$, which is positive with $\delta \leq 2.14$. The value of the total possible loss is determined by:

$$L = (-36) \times 0.25 \times \delta \tag{12}$$

If an individual chooses to flip three coins simultaneously, the utility function would take form:

$$U = w_1 \times 0.125 + w_2 \times 0.375 + l_1 \times 0.375 + l_2 \times 0.125 \times \delta \tag{13}$$

Again, with the 100 unit bet the utility is as follows:
$U = 120 \times 0.125 + 35 \times 0.375 - 17 \times 0.375 \times \delta - 49 \times 0.125 \times \delta$ with positive U at $\delta \leq 2.27$. And total possible losses are determined as:

$$L = -17 \times 0.375 \times \delta - 49 \times 0.125 \times \delta \tag{14}$$

From the abovementioned utility and total possible loss equations (9-14) we can see that choosing to flip three coins simultaneously brings the highest expected utility $U = w_1 \times 0.125 + w_2 \times 0.375 + l_1 \times 0.375 + l_2 \times 0.125 \times \delta$. On the other hand, if we consider only total possible losses, flipping two coins simultaneously results in the smallest total possible loss $L = l_1 \times 0.25 \times \delta$. According to this logic loss-averse individuals should avoid flipping one coin at a time because it results in lowest utility for a single flip. However, if we take into account behavioural biases and individuals' myopia, we may well expect that individuals will often choose to flip one coin at a time and thus experience temporary losses more often if there are no incentives to do otherwise. This means that individuals are assumed to be myopic and to frame their choices narrowly if there are no clear contrasts in available options. Binomial lattice of the coin flipping game is shown in Figure 6 in Appendix 12.

4.1.2 Game structure and relation to hypotheses

To elaborate further on experimental hypotheses and expected results I first have to determine the experimental structure in more concrete terms. In this section I describe the terms and definitions of the coin flipping game properties and express my hypotheses in these terms.

As stated above, the coin flipping game consists of twelve periods of time during which individuals choose their bets and number of coins to be flipped simultaneously. Let us denote the amount of game units available for individual as A and bet amount as B. In addition, let us define time periods as $t = 0,1,...,12$ and the number of coins chosen to flip simultaneously as $f_x = 1,2,3$, where f_1 refers to flipping one coin at a time, f_2 to flipping two coins simultaneously and f_3 to flipping three coins simultaneously. From these definitions we can write the first equation determining the relative amount of bet at time t.

$$^{B}I_t = \frac{B_t}{A_t} \text{, and } ^{D}I_t = 1 - {^{B}I_t} \tag{15}$$

where $^{B}I_t$ is the relative amount of assets assigned to bet at time t ($t = 0,1,...,11$) and $^{D}I_{t\,t}$ is the relative amount of assets deposited. The decision process that an individual faces can also be presented in a form of a binomial lattice shown in Figure 6 in Appendix 12. In this way, depending on the amount of coins chosen to be flipped simultaneously at time t i.e. the evaluation period, the next relative bet amount can be written as:

$$^{B}I_{t+f_x} = \frac{B_{t+f_x}}{A_{t+f_x}} \tag{16}$$

The final unit amount, which also determines the amount of funds paid to an individual, is determined by A_{12}, as individuals are unable to place any bets at $t = 12$. The number of times individuals are able to place bets $n_b = 4,5,...,12$ varies depending on the $f_x = 1,2,3$ e.g. an individual can choose to flip three coins simultaneously four times, one coin at a time twelve times or anything in between, thus we can write that the number of bets made by individuals during the game is:

$$n_b = n_1 + n_2 + n_3 \;;\; 4 \le n_b \le 12 \text{, where} \tag{17}$$

$$n_1 f_1 + n_2 f_2 + n_3 f_3 = 12 \;;\; 0 \le n_1 \le 12,\; 0 \le n_2 \le 6,\; 0 \le n_3 \le 4 \tag{18}$$

Now let us express outcome expectations and hypotheses in terms described above. Because in Hypothesis H1 we are interested in the relative bet amounts with changing evaluation frequency we can define this hypothesis according to MLA theory i.e. with lower evaluation frequency the relative bet amounts should increase.

$$\text{If} \quad {}^{1}n_b > {}^{2}n_b, \quad \text{then} \quad \frac{\sum_{t=0}^{11} {}^{B}I_t}{{}^{1}n_b} < \frac{\sum_{t=0}^{11} {}^{B}I_t}{{}^{2}n_b} \tag{19}$$

This means that more portfolio evaluations i.e. more coin flips, result in relatively lower bet amounts. However, this equation is rather vague and there is a reason to determine a more specific interpretation for MLA preferences in the game, which would be determined only by the current state t. We can write:

${}^{f3}\left[{}^{B}I_t\right] > {}^{f2}\left[{}^{B}I_t\right] > {}^{f1}\left[{}^{B}I_t\right]$, where $f_x = 1,2,3$ are the evaluation frequencies chosen at time t.

This simply means that choosing fewer coins to flip at time t would result in higher bet amount at that time ${}^{B}I_t$.

Now if we consider Hypothesis H3, which basically states that the magnitude of ${}^{B}I_t$ has an influence on the ${}^{B}I_{t+1}$ i.e. the extent of the disposition effect is greater with higher ${}^{B}I_t$. We can express this in a more general form as:

If $^{B1}I_t > ^{B2}I_t$, then $\frac{|^{B2}I_{t+1} - ^{B2}I_t|}{^{B2}I_t} < \frac{|^{B1}I_{t+1} - ^{B1}I_t|}{^{B1}I_t}$ or simply $\Delta^{B1}I > \Delta^{B2}I$ (20)

In other words, this equation states that with smaller ^{B}I at time t, the change in ^{B}I will be smaller at $t+1$. This is mainly based on the rationale discussed in previous sections and on the dual mental account approach. Practically, this logic implies that individuals with higher amounts assigned to bet $^{B}I_t$ will secure higher portion of gains at $t+1$ or increase their bet if losses occur at $t+1$ thus acting in appliance with the disposition effect.

Using the same notations as above, we can define properties for Hypothesis H4, which concerns gender differences in evaluation frequency and bet size. We can denote values related to males with m and values related to females with w and the sample size could be denoted as N. From this H4 can be expressed as:

$$\frac{\sum {}^{w}n_b}{{}^{w}N} > \frac{\sum {}^{m}n_b}{{}^{m}N} \text{ and } \frac{\sum {}^{wB}I}{\sum {}^{w}n_b} < \frac{\sum {}^{mB}I}{\sum {}^{m}n_b} \quad (21)$$

This expression refers to the statement that women will evaluate their portfolio more often and their bet amounts will be smaller. In later section I will use the same notations to express expectations about outcomes and other experimental settings.

4.2 Subject groups

Subject groups in the experiment include undergraduate student and market practitioners. Student group consists of 182 undergraduate students from Helsinki School of Economics (HSE) and professional group consists of 18 market practitioners from various listed Finnish companies. All participants were randomly selected from the sample and the only selection criterion was the approximately same number of male and female participants in all subject groups. I wanted to include both groups, students and professionals, in my experiment because several studies suggest that to obtain more relevant results (i.e. results that can be applied to real markets), behavioural experiments must include individuals who are actually involved in transactions and have an influence in the real markets. As discussed in earlier sections, many experimental studies show that there can be significant differences in the behaviour of students and market professionals (e.g. studies by Haigh and List, 2005; Kaustia, Alho and Puttonen, 2008) and thus it is essential to make a distinction between them. Otherwise the experimental setting including granted funds is similar for all subject groups and differences occur only in different treatments.

4.3 Data and methods

All the data was collected from the internet application, which was designed and constructed specifically for the purposes of this experiment. The participation request was sent to selected subjects via e-mail along with individual referral code. The structure of this application excluded all possibilities of cheating and inappropriate result manipulation. In this section I describe how and what data was collected as well as for what purposes it is used.

4.3.1 Data gathering

The experiment is conducted by sending an application via internet to undergraduate students and market practitioners. This application involves basic information form, test for expectations and confidence levels and a coin flipping game. The database is then formed from the experiment responses. Experiment participants received an e-mail including a link to the application with personal referral code. This code allowed participants to go through all steps of the application without possibility to return to previous steps. In this way I make sure that there are no cheating possibilities and that all responses are counted for. The dataset collected consists of the following parts:

(1) Basic information
(2) Expectations and confidence levels
(3) Decisions and results in the coin flipping game
(4) Additional information

Basic information (1) includes information about gender, age and occupation and provides a base for testing hypothesis H4. Expectations and confidence level section (2) includes questions about expectations concerning the final outcome of the participant, average final wealth of all participants and confidence levels assigned to these expectations. Individuals are asked to

estimate their final game unit amount at the end of the experiment with +/-20% accuracy. Participants are also asked to indicate their confidence level, which represents the certainty (0-100%) in their final unit amount estimate e.g. 90% confidence level means that an individual is 90% certain that his final unit amount will fall within +/-20% range from his final unit amount estimate. The data collected from the coin flipping game itself (3) consists of evaluation frequencies i.e. how many coins an individual has chosen to flip simultaneously, bet amounts i.e. relative bet amounts compared to total units available to bet, and the game outcomes. Data collected from the coin flipping game is mainly used to test hypothesis H1.
Additional information (4) includes amount of funds transferred to charity and bank account information. This information is collected to transfer funds to experiment participants and see how if there is any relation between game performance and funds donated to charity.

4.3.2 Testing for overconfidence

To include a test for overconfidence in my experiment I use same methods as in earlier studies concerning this topic. Namely, after familiarizing the game participants with the game rules, I ask them to estimate their unit amount at the end of the game and to indicate their certainty level, which determines how certain individuals are that their estimated final unit amount will fall within +/-20% estimation range. I also ask for the estimation of the average final unit amount of all participants using the same logic. Overconfident individuals will be more certain about their final unit estimates than individuals will be actually right on average. In other words, overconfident individuals will indicate a higher certainty level for their estimates and also overestimate their final unit amount compared to the average unit amount of all participants. Visual representation of this experiment stage is shown in the Appendix 2. Let us determine being right as r, then the percentage of all game participants being right about their final unit estimate R can be written simply as:

$$R = \frac{\sum r}{N} \times 100 \tag{22}$$

We can also define individuals' final unit estimate as E^i and their average final unit estimate as E^a. Now we can write the definition for overconfidence used in the experiment. Overconfident individuals are expected to have the following properties:

$E^i > R$ and $E^i > E^a$ (23)

This overconfidence distinction will provide a base for testing for the Hypothesis H2, which states that overconfident individuals will evaluate more frequently and have higher bets. Let us define overconfidence as u write the property for it as:

$$\frac{\sum {}^{uB}I}{\sum {}^{u}n_b} > \frac{\sum {}^{B}I}{\sum n_b} \quad (24)$$

Thus the average bet of overconfident individuals is greater than an average bet of all game participants. From previous sections we remember that there is a distinction between types of overconfidence. In this experimental setting the overconfidence rising from property $E^i > R$ can be described as misconception of probability i.e. one thinks that the outcome is more likely than it actually is e.g. wishful thinking. On the other hand, the overconfidence arising from the property $E^i > E^a$ can be considered as belief in one's superior information or skills.

4.3.3 Funds and fund transfer

As briefly mentioned, all game units in my experiment are backed up with real money, which is paid to participants to their bank accounts if they have filled all the necessary information in the application. There are several reasons for using real money in the experiment, including better incentives and higher response rates as well as higher comparability with real-life situations. However, there could be also negative side effects such as house-money effect, which may lead to the opposite results that were intended. One important feature in my experiment, by which I try to compensate for problems related to real money incentives, is the possibility to donate the gained funds to charity. It is argued that this incentive may even out the initial gambling attitude of participants and induce a more careful and reasonable behaviour. This rationale is based on the assumption that when small sums of money are involved, small differences in these sums, which are negligently small to make any difference for the individual himself, are counted for as they are given willingly to someone in need. As an example, consider donating for charity or giving a tip to someone. The difference between donating or giving a tip of 3€ or 5€ seems to be relatively significant, but for the donor himself the additional 2€ in the pocket is hardly significant. In this way, I try to stimulate participants to make considered decisions and to avoid seeing the experiment purely as free money or a gambling opportunity.

I also collect data on how much of their gained funds individuals are willing to give to charity. These data is not used in any of the presented hypotheses but could be used later to analyze individuals' attitudes toward monetary rewards and the experiment itself. Table 11 in Appendix 5 shows relative number of individuals donating to charity among different subject groups.

4.4 Treatments

My experimental setting involves three treatments which differ from each other in terms of financial incentives provided for portfolio evaluation frequency choices. These treatments allow to test whether financial incentives can reduce evaluation frequency and through that increase amount invested in risky assets. In addition, different treatments may help to find differences in reactions to financial incentives among males and females as well as students and professionals.

Basic treatment serves as a reference platform for other treatments. In this treatment individuals choose to flip one, two or three coins without any financial incentives provided for these options. Based on the MLA theory, it is assumed that the majority of individuals will choose to flip one coin at a time because of narrow framing. This assumption is essential from the point of view of this study as my main hypotheses lean on it heavily. In mathematical terms this expectation can be written as:

$$\frac{\sum n_b}{N} \rightarrow 12 \text{, for Basic treatment} \qquad (25)$$

According to MLA frequent evaluation brings lower utility for loss-averse individuals, but because there are no restrictions for individuals' myopia i.e. all frequency options seem to be equal with no specific incentives, the most frequent option is likely to be chosen. To distinguish whether providing incentives for choosing lower evaluation frequency results in higher bet amounts ${}^{b}I$, I introduce two more treatments in addition to the basic one. In the "carrot" treatment the option to fillip three coins simultaneously is made more attractive by providing a fixed unit bonus for choosing it. In the "stick" treatment there is a fixed unit fee for choosing to flip only one coin at a time. I believe that introducing different financial incentive such as bonuses and fees may help to distinguish which of them give a better result, if there is one. In other word, I assume that the response to fees and bonuses is rather different, because the behavioural concepts behind them are different although they result in equal wealth loss or gain.

4.4.2 Carrot treatment

As mentioned previously, carrot treatment is about providing financial incentives for low evaluation frequency (flipping three coins simultaneously) in the form of bonuses. When participants enter the coin flipping game, there is a notion that says that participants will receive a 15 unit bonus each time they choose to flip three coins simultaneously. The idea behind this treatment is to make myopically loss-averse subjects to trade their otherwise myopic choice for the financial benefit. This financial benefit or a bonus, as I later refer to it, is said to be paid at the end of the experiment and in this way it does not influence the unit amounts during the game. By enhancing low evaluation frequency option the experimental setting tries to manipulate the framing of individuals i.e. flipping three coins simultaneously means broader framing and longer evaluation period. The assumption is that with financial incentives are provided the majority of carrot treatment subjects will choose this option because sure gain is greater than zero. This can be written as:

$$\frac{\sum n_b}{N} \rightarrow 4 \text{, for carrot treatment} \qquad (26)$$

However, shifting decisions with financial incentives is insufficient from our perspective if it does not result in averagely higher bet amounts as predicted by MLA theory. Let us denote basic treatment as T, carrot treatment as $T1$ and stick treatment as $T2$. In this way we can write the expected outcome for this treatment as:

$$^{T}\left[\frac{\sum n_b}{N}\right] > {}^{T1}\left[\frac{\sum n_b}{N}\right] \text{, and } {}^{T}\left[\frac{\sum {}^{B}I}{\sum n_b}\right] < {}^{T1}\left[\frac{\sum {}^{B}I}{\sum n_b}\right] \qquad (27)$$

$$\text{and } {}^{f3}\left[{}^{B}I_t\right] > {}^{f2}\left[{}^{B}I_t\right] > {}^{f1}\left[{}^{B}I_t\right] \text{ within treatments} \qquad (28)$$

On the other hand, if the relative bet amount within the low evaluation frequency drops significantly, it means that financial incentives did not have an effect on subjects' preferences toward loss aversion to the sufficient extent. There is also a possibility that financial enhancement of the low evaluation frequency will have no impact on one's option choices at all. This might be due to relatively low bonus and low stakes involved in this experiment. This is one reason why I try not to stress the exchange rate of units to Euros and in this way make the actual Euro reward less accessible.

4.4.3 Stick treatment

In the stick treatment individuals are facing a 5 unit fee each time they choose to flip one coin at a time. Contrary to the carrot treatment, financial incentives take a form of penalty and in this way make the high evaluation frequency unattractive. This means that now both other options (flipping two and three coins simultaneously) are enhanced. It can be assumed, based on the same rationale as before, that even though highest evaluation frequency is now unattractive to all individuals, narrow framing will make the majority to choose the next highest evaluation frequency available i.e. to flip two coins at a time. This notion can be presented as:

${}^{f1}[n_b] < {}^{f3}[n_b] < {}^{f2}[n_b]$, where $f_x = 1,2,3$ are the evaluation frequencies (29)

and ${}^{f3}[{}^{B}I_t] > {}^{f2}[{}^{B}I_t]$ within treatments (30)

However, the main point of interest is the comparison between treatments and finding whether financial incentives increased average bets of individuals and through that the overall final wealth. As discussed in previous sections, it is expected that the majority of subjects will choose to fillip one coin at a time in the basic treatment, two coins at a time in the stick treatment and three coins at a time in the carrot treatment. If this expectation holds, it would mean that even small financial incentives can shift asset allocation choices. This would provide a good base for comparison between treatments where the average bet size is the key concern. Again, according to MLA, the lowest evaluation frequency results in higher bets and higher final wealth and assuming that financial incentives result in expected effects, the following inequality should hold:

$$ {}^{T}\left[\frac{\sum {}^{B}I}{\sum n_b}\right] < {}^{T3}\left[\frac{\sum {}^{B}I}{\sum n_b}\right] < {}^{T2}\left[\frac{\sum {}^{B}I}{\sum n_b}\right] \quad (31) $$

This simply means that after standardized for the sample size of each treatment group the average bet size should be highest in the carrot treatment, second highest in the stick treatment and lowest in the basic treatment. Even if the assumption ${}^{T}\left[\frac{\sum n_b}{N}\right] < {}^{T3}\left[\frac{\sum n_b}{N}\right] < {}^{T3}\left[\frac{\sum n_b}{N}\right]$ does not hold, we can still see the difference between bet sizes with different evaluation frequencies by retrieving different evaluation frequencies and bet sizes separately from the data.

5. Results and analysis

This section presents the experiment process, main results and analysis. To avoid undesired outcomes and to make sure that the application worked properly I first conducted my experiment with a small group of 31 individuals but without monetary rewards. Results obtained from the test group were primarily used to analyze whether experiment application was ready for the core experiment group. In contrast with the core group I collected feedback from the preliminary experiment subjects and in this way this phase allowed me to correct some relevant flaws in the application and the whole experimental setting.

Without preliminary testing of experiment application it was impossible to predict whether some unexpected behaviour would occur. For example, some undesired scenarios could include (1) over 90% of individuals choosing to flip only a certain amount of coins e.g. one coin at a time, (2) individuals placing only maximum bets and (3) individuals misunderstanding the problem or rules of the game. Despite small sample size, results obtained from the preliminary test group did not indicate any significant undesired outcomes and variability in coin flipping choices was present in all treatments. Perhaps the most important insight obtained from the test group was the successful effect of financial incentives on subjects' evaluation frequency choices i.e. in the basic treatment most individuals preferred to flip one and three coins at a time to flipping two coins, in the carrot treatment subjects favoured the three coin option and subjects in the stick treatment favoured the two coin option. My preliminary test group included only 3 female subjects and 8 professionals, thus analyzing aspects related to gender differences and differences between students and professionals based on this sample was limited.

5.1 Core experiment group summary statistics

After analyzing results and feedback from preliminary subject group several corrections were made to the internet application, which were mostly related to clarifications in game rules and fund transfer options. To assemble core experiment group I collected an e-mail list totalling in 920 addresses (HSE e-mails of students and company e-mails of professionals). Invitations to the experiment were then sent to potential participants in groups of 300 people with one week intervals to ensure control over response rate and available budget. Experiment survey period lasted for three weeks after which there were 236 indicating a response rate of 25.6%. From 236 participants 36 persons did not complete the survey to the point of fund transfer, thus core sample group used in my analysis consists of 200 individuals. Table 1 summarizes core subject group statistics. Although invitation to participate was sent to equal number of males and females the response rate from females was only half the one of males. This could be partially explained by higher risk aversion of women, in this case probably related to internet security issues because invitations were sent by e-mail and messages included a link which individuals were asked to follow to participate in the experiment (message sent to participants is shown in Appendix 4).

Sending invitations in bunches over extended time period enabled to control how many participants were in each treatment and as a result numbers of participants and ratio of women/men in each treatment do not differ significantly. Average age in each treatment is also approximately around 25 years with Stick treatment having slightly higher average age due to more individuals with age around 50. Interestingly, when comparing average gains of individuals among treatments, individuals in Carrot treatment gained 20% more on average than individuals in Basic treatment. On the other hand, individuals in Stick treatment gained 10% less on average than individuals in Basic treatment although average number of coins returning positive outcome was close to 6 in all three treatments. From the perspective of individuals' rationality, subjects in both treatments manipulated by financial incentives displayed significant number of economically irrational choices by neglecting bonuses in Carrot treatment and paying fees in Stick treatment. However, individuals who did not pay fees or did take bonuses in the first round also tended to maintain this strategy throughout the game.

Table 1: Summary statistics

This table displays summary statistics for the core subject group consisting of 200 persons. Summary statistics include number of participants, gender, occupation, average age and major segmented by treatment. This table also shows relative amount of bonuses and fees taken in separate treatments.

		By treatment		
	All	Basic	Carrot	Stick
Participants N	**200**	**64**	**67**	**69**
Females	64	21	20	23
Students	182	61	60	61
Average age	**25**	**25**	**25**	**26**
Median	24	24	24	24
Stdev.	4.27	3.81	3.33	5.35
Finance as a major*	26%	25%	28%	25%
Average gain	**23%**	**20%**	**40%**	**10%**
Median	0.13	0.14	0.21	0.07
Stdev.	0.64	0.55	0.84	0.42
Portion of bonuses not taken			**38%**	
Median			0.25	
Stdev.			0.39	
Portion of fees paid				**24%**
Median				0.08
Stdev.				0.33

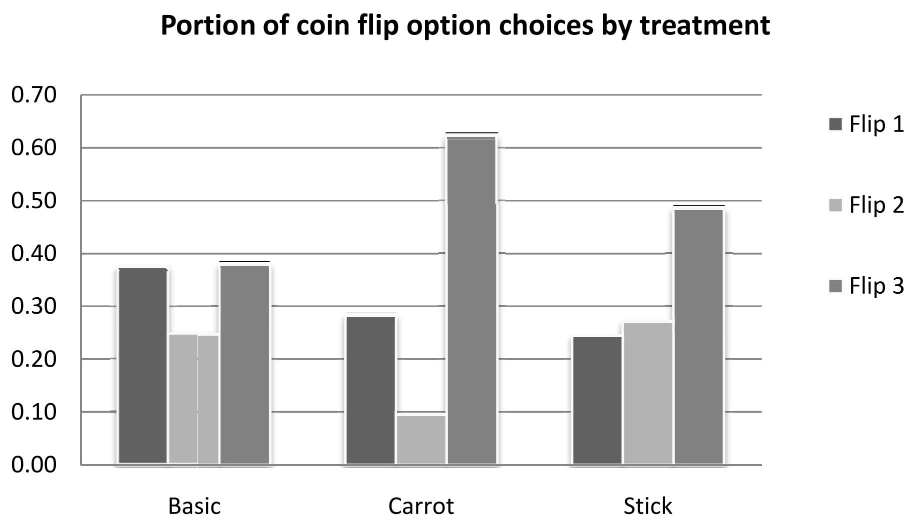
*students

5.2 Evaluation frequency among subject groups

Adjusted portions of coin flip choices of experiment participants are displayed in Chart 1. Numbers of coin flip option choices in Chart 1 are adjusted by the total number of these options available in the game, thus displaying comparable evaluation frequency preferences with different coin flip options i.e. number of "Flip 3 coins" options is adjusted by 4, number of "Flip 2 coins" options is adjusted by 6 and number of "Flip 1 coin" options is adjusted by 12. Comparing adjusted coin flip option choices shows that individuals in Basic treatment favoured one-coin and three-coin options whereas individuals in Carrot and Stick treatments favoured the three-coin option above all other options. These results indicate partial appliance with expected outcomes as financial incentives successfully shifted individuals' preferences toward three-coin option in Carrot treatment and away from one-coin option in Stick treatment. However, despite manipulations with financial incentives aimed on reducing individuals' reviewing frequency, portion of one-coin options remained relatively high in all treatments and formed around 26% of all coin flip option choices also in manipulated treatments (Carrot and Basic). This is an indication of some individuals being more sensitive to investment flexibility than to sure gains or losses.

Chart 1: Coin flip option choices

This chart displays adjusted amounts of coin flip choices by treatment. Numbers are adjusted by maximum available coin flips for each coin flip option in 12-round game i.e. maximum number of three-coin flips is 4, 6 for two-coin flips and 12 for one-coin flips. Adjusted numbers of coin flips reflect actual evaluation frequency preferences. Carrot treatment includes bonuses for choosing "Flip 3 coins" options and Stick treatment includes fees for choosing "Flip 1 coin" options.



High number of one-coin options cannot be explained by the final stage of the game (Periods 10 and 12) where individuals' choices were limited to flipping options that would give a total number of 12 flips. From the point of view of this experiment, sustaining variability in coin flip option choices was favourable as it allowed me to analyze the effect of evaluation frequency on relative bets within treatments in addition to cross treatment analysis. Table 2 shows adjusted portions of coin flip option choices as well as number of bet reviews separately for subject groups and treatments. These findings suggest that even relatively insignificant financial incentives (Maximum amount of bonuses or fees received/paid was 60 game units forming 6% of initial unit amount and equal to 30 cents) can change evaluation frequency of individuals. In Carrot treatment subjects favored "Flip 3 coins" option 24 percentage points more than in Basic treatment and in Stick treatment individuals chose "Flip 1 coin" option 13 percentage points less often than in Basic treatment. Results in Table 2 indicate that women had on average more reviews than men in Basic treatment (7.14 vs. 6.16 out of maximum 11 reviews) but the difference is not statistically significant (Mann-Whitney test). However, it is interesting to note that difference in average number of reviews between males and females is reduced in manipulated treatments.

Table 2: Number of reviews and adjusted coin flip option preferences

This table shows adjusted portions of coin flip option choices by treatment. Numbers are adjusted by maximum available coin flips for each coin flip option i.e. maximum number of three-coin flips is 4, 6 for two-coin flips and 12 for one-coin flips. Adjusted numbers of coin flip options reflect actual evaluation frequency preferences. Overconfidence type 1 is related to individuals overestimating accuracy of their forecasts and Overconfidence type 2 is related to individuals who believe in better than average performance. Carrot treatment includes bonuses for choosing "Flip 3 coins" options and Stick treatment includes fees for choosing "Flip 1 coin" options. This table also shows average number of reviews in each treatment i.e. how many times individuals reviewed their bets on average (Minimum is 3 times and maximum is 11 times).

		By treatment		
	All	Basic	Carrot	Stick
Portion of coin flip choices				
Flip 1 coin	30%	37%	29%	24%
Flip 2 coins	20%	25%	9%	27%
Flip 3 coins	50%	38%	62%	49%
Average number of reviews	**5.80**	**6.48**	**5.45**	**5.49**
Males	5.71	6.16	5.43	5.59
Females	5.97	7.14	5.50	5.30
Overconfident (type 1)	5.86	6.56	5.47	5.64
Overconfident (type 2)	6.10	7.33	5.29	5.69

Chart 2 in Appendix 6 displays changes in coin flip option preferences during time periods (presented in bunches of three) indicating that higher evaluation frequency is preferred in the beginning and at the end of the coin flipping game. This can be due to psychological effect where individuals want to follow performance more closely at the beginning and at the end but are less concerned about intermediate steps. Number of one-coin flips is also increased in periods 10 and 11 because there are no three-coin (Periods 10 and 12) and two-coin options available (Period 11). On the other hand, three-coin option is favoured in periods 4-6 and this tendency is observed in all three treatments (Basic, Carrot and Stick). I find that individuals who estimated their performance to be better than average (Overconfidence type 2) reviewed their portfolio slightly more often than not overconfident individuals (6.10 vs. 5.76 overall and 7.33 vs. 6.08 in Basic treatment). However, the difference is not statistically significant according to non-parametric significance test (Mann-Whitney test).

5.3 Bet size and differences among subject groups

I find that gender effect is present and systematic within the whole subject group as females placed lower bets than males in all treatments (See Table 3). Difference between bets of men and women is statistically significant according to non-parametric significance test (Table 13 in Appendix 5). When analyzing differences between bets with different coin-flip options, males placed significantly higher bets with three-coin option whereas females seem to be insensitive toward evaluation frequency. This difference between males and females for overall experiment group is mainly caused by bet differences in Basic treatment where males placed 20 percentage points higher bets with three-coin option compared to one-coin option but differences between bets with different coin-flip options of females were statistically insignificant. When looking at differences between bets with different coin flip options, difference between genders is reduced in manipulated treatments as there are no statistically significant differences in bet size with different coin flip options in Carrot and Stick treatments.

Professionals on the other hand had lower bets than students (0.36 vs. 0.49) and the difference is statistically significant. Because I had only 18 professionals in the whole experiment group it was not possible to reasonably analyze their behavior by treatment.

Table 3: Bet size and gender differences

This table shows average bets of males and females separately by coin flip options. Carrot treatment includes bonuses for choosing "Flip 3 coins" options and Stick treatment includes fees for choosing "Flip 1 coin" options.

		By coin flip option		
	All coin flip options	**Flip 1**	**Flip 2**	**Flip 3**
Male				
Average	**0.51**	**0.50**	**0.42**	**0.58**
Median	0.40	0.39	0.30	0.53
Stdev.	0.39	0.40	0.35	0.39
Female				
Average	**0.37**	**0.37**	**0.35**	**0.37**
Median	0.23	0.19	0.27	0.27
Stdev.	0.34	0.37	0.27	0.32

5.4 Overconfidence among subject groups

As discussed in previous sections, I include tests for two types of overconfidence in my experiment. First type of overconfidence (Overconfidence type 1) is related to miscalibration of probabilities and is present when individuals overestimate certainty of their forecasts. In the beginning of the experiment subjects were asked to estimate their final unit amount and an average final unit amount of all participants. From 200 individuals 17 were excluded from overconfidence tests as they clearly misunderstood questions related to final unit amount estimates. Game stage for overconfidence testing is shown in Appendix 2. Correctness level related to outcome forecasts among all individuals was 34% (Correctness level represents portion of individuals being correct about their final unit amount forecasts), which is relatively high taking into account large variance of possible outcomes. However, 83% of all individuals chose certainty levels equal to or greater than 40%, thus overestimating actual chances of being correct about their forecasts.

The second type of overconfidence (Overconfidence type 2) used in my experiment is a measure related to better than average effect i.e. individuals forecasting that their final unit amount will be greater than average. From 183 individuals included in overconfidence tests 33% estimated their outcome to be greater than average but only 51% of these individuals actually performed so. Table 4 shows relative amount of overconfidence type 1 and type 2 present in all treatments segmented by subject groups. It is important to note, that in Carrot treatment there were relatively more males with overconfidence type 2 and in Stick treatment presence of type 2 overconfidence was lower mostly due to lower number of overconfident females. In addition, I find that women were 10% less certain about their final outcome forecasts suggesting lower type 1 overconfidence.

Table 4: Overconfidence in separate treatments

This table displays portions of overconfident individuals segmented by treatment, gender and occupation. Overconfidence type 1 is related to individuals overestimating accuracy of their forecasts and Overconfidence type 2 is related to individuals who believe in better than average performance. Carrot treatment includes bonuses for choosing "Flip 3 coins" options and Stick treatment includes fees for choosing "Flip 1 coin" options.

		By treatment		
	All	Basic	Carrot	Stick
Overconfidence (type 1)	**83%**	**76%**	**80%**	**92%**
Males	79%	72%	79%	87%
Females	69%	67%	60%	78%
Professionals	78%			
Students	76%			
Overconfidence (type 2)	**33%**	**36%**	**39%**	**25%**
Males	34%	33%	38%	30%
Females	23%	33%	30%	9%
Professionals	50%			
Students	29%			

Individuals who estimated better than average performance (Overconfidence type 2) placed higher bets than individuals who estimated average or below average performance indicating that overconfident subjects tend to place higher bets (Table 14 in Appendix 5 shows Overconfidence type 2 statistics separately by treatment). Differences between relative bets of overconfident and not overconfident individuals are statistically significant in Carrot and Stick treatments but insignificant in Basic treatment (Overall difference is statistically significant). I also include a regression analysis with average bet as dependent variable to try to estimate relationship between average bet, number of bet reviews and overconfidence. Table 5 displays regression model outcomes and indicates that there is a positive relationship between overconfidence type 2 and average bet. On the other hand, overconfidence type 1 seems to be unrelated to average bet. One possible reason for this might be that individuals did not familiarize themselves enough with the game rules before indicating certainty level of their forecasts.

Table 5: Average bet and overconfidence effect

The dependent variable is average bet. *No. of reviews* is an explanatory variable representing the number of times individuals reviewed their bets. *Overconfidence type 1* is a dummy for overconfidence related to miscalibration of probability and *Overconfidence type 2* is a dummy for overconfidence related to better than average effect. *Male* is dummy for gender and *Professional* is dummy for occupation.

	All	Individuals with average bet 1 excluded
No. of reviews	**-0.01**	**-0.01**
	(-1.26)	(-1.78)
Professional	**-0.20***	**-0.17***
	(-2.23)	(-2.52)
Male	**0.16****	**0.07***
	(3.01)	(1.87)
Overconfidence type 1	**-0.02**	**0.00**
	(-0.26)	(0.05)
Overconfidence type 2	**0.10***	**0.11****
	(1.99)	(2.78)
Constant	**0.43*****	**0.35*****
	(5.24)	(5.41)
Observations	183	146
R squared	0.095	0.120
Significance F	0.003	0.003

*** Significant at 0.001 level, ** Significant at 0.01 level, * Significant at 0.05 level. Values in brackets are t-statistics.

5.5 MLA effect and bet size with different coin flip options

The main aim of this study was to find out whether manipulations with financial incentives can increase individuals' risk-taking by reducing their portfolio evaluation frequency. Introducing financial incentives in Carrot and Stick treatments shifted individuals' choices but maintained enough variability within treatment groups to enable within treatment analysis. When analyzing average bets with different coin flip options of the whole subject group, average bet with three-coin option is 6 percentage points higher than average bet with one-coin option and the difference is statistically significant. This general finding suggests that MLA effect holds and that individuals choosing lower evaluation frequency place higher bets. However, when separate treatments are analyzed (See Table 6), average bet in Carrot treatment is 10 percentage points higher than in Stick treatment and 12 percentage points higher than in Basic treatment and differences are statistically significant (Table 15 in Appendix 7 shows Mann-Whitney significance test results). This is partially due to anomalously high bets with one-coin option in Carrot treatment, which are significantly higher than in Basic and Stick treatments. Average bet development for separate coin flip options during 12 periods of the coin flipping game is illustrated in Chart 3 (Appendix 8), showing that bets with one-coin option in Carrot treatment are higher than in other treatments during the whole game period. Average bets with three-coin option are not statistically different in Basic and Carrot treatments (0.56 vs. 0.54) but Stick treatment has significantly lower three-coin option average bet (0.46). In addition, differences between bets with one-coin, two-coin and three-coin options were not statistically significant in Stick treatment, indicating that MLA effect did not apply.

From abovementioned findings only Basic treatment indicates strong presence of MLA while Carrot and Stick treatments do not show differences in average bet size between one-coin and three-coin options. However, when looking at the initial bet of experiment subjects, bet size with three-coin option is significantly higher than with other options in all treatments (As shown in Chart 4 in Appendix 9). To study why individuals place significantly higher bets with one-coin option in Carrot treatment, significantly lower bets with three-coin option in Stick treatment and how bets evolve during the game periods I construct a regression model for testing influences of different factors on bet size and later conduct separate analysis for subject group where individuals with average bet of one and zero are excluded.

First I analyzed effects of coin flip option choices, gender and time period on bets of individuals. Table 7 displays results from the regression model for combined subject group and separately by treatments. Again, only Basic treatment shows strong presence of MLA throughout the game as bets with three-coin option tend to be significantly higher than with other evaluation frequency options. In other two treatments (Carrot and Stick) differences between bet sizes with one-coin and three-coin options are insignificant. Game period has a positive influence on bet size and bets increase toward the end of the game. Chart 3 in Appendix 8 shows that bets with all coin flip options increase during the game although bets with three-coin options increase slower than bets with one-coin option.

Table 6: Bet size by coin flip option in separate treatments

This table shows average bets of individuals in different treatments by coin flipping options. Carrot treatment includes bonuses for choosing "Flip 3 coins" options and Stick treatment includes fees for choosing "Flip 1 coin" options.

		By coin flip option		
	All coin flip options	**Flip 1**	**Flip 2**	**Flip 3**
All treatments				
Average	**0.46**	**0.46**	**0.40**	**0.52**
Median	0.32	0.31	0.30	0.38
Stdev.	0.38	0.39	0.33	0.38
Basic				
Average	**0.42**	**0.39**	**0.38**	**0.56**
Median	0.27	0.20	0.25	0.52
Stdev.	0.38	0.38	0.33	0.41
Carrot				
Average	**0.54**	**0.57**	**0.33**	**0.54**
Median	0.46	0.52	0.22	0.48
Stdev.	0.38	0.40	0.27	0.37
Stick				
Average	**0.44**	**0.42**	**0.44**	**0.46**
Median	0.29	0.25	0.32	0.28
Stdev.	0.37	0.38	0.35	0.38

I stated earlier that MLA effect was present in Basic treatment and that individuals choosing to flip three coins at a time had significantly larger bets than individuals choosing to flip one coin at a time. This statement applied to the investment period in general but it is important to note that this did not hold in every period of the coin flipping game. I find that individuals choosing low evaluation frequency in the first period had significantly larger bets than individuals choosing low evaluation frequency in later periods. This resulted in high changes of average bet magnitudes with three-coin option in different periods. Subjects who chose three-coin options in periods 1, 4, 7 and 10 had significantly higher bets than individuals choosing one-coin options but individuals who chose three-coin options in periods 2, 3, 5, 6 and 9 had significantly lower bets than individuals choosing one-coin options in respective periods. Similar bet size pattern can be observed in all treatments. However, such variability of three-coin option bets among different investment periods is due to very small number of individuals choosing to flip three-coins at time in periods 2, 3, 5, 6 and 9, thus I choose to present average bets by period in bunches of three periods as in Chart 3 in Appendix 8. I find that individuals choosing one-coin options in Carrot treatment had significantly higher bets than in other treatments already in the first period whereas bets with three-coin option followed similar pattern as in Basic treatment. This result provides additional evidence that higher average bets of individuals with high evaluation frequency in Carrot treatment is not due to any single period but is constantly higher in all periods.

Table 7: Bet size and coin flip options

The dependent variable is relative bet size. *Flip 1* and *Flip 3* are dummies for choosing to flip one or three coins respectively. *Male* is a dummy for gender and *Period* is a game period variable (Periods 1-12). Carrot treatment includes bonuses for choosing “Flip 3 coins” options and Stick treatment includes fees for choosing “Flip 1 coin” options.

		By treatment		
	All	Basic	Carrot	Stick
Male	**0.14*****	**0.05**	**0.17*****	**0.18*****
	(6.70)	(1.43)	(4.64)	(5.11)
Flip 1	**0.04**	**0.00**	**0.23*****	**-0.03**
	(1.62)	(-0.07)	(3.63)	(-0.71)
Flip 3	**0.12*****	**0.18*****	**0.23*****	**0.03**
	(4.13)	(3.45)	(3.54)	(0.61)
Period	**0.02*****	**0.02*****	**0.03*****	**0.02*****
	(8.27)	(4.53)	(5.30)	(4.77)
Constant	**0.17*****	**0.22*****	**0.05**	**0.18*****
	(5.19)	(4.20)	(0.70)	(3.57)
Observations	1357	479	431	447
R squared	0.086	0.077	0.130	0.112
Significance F	0.000	0.000	0.000	0.000

*** Significant at 0.001 level, ** Significant at 0.01 level, * Significant at 0.05 level. Values in brackets are t-statistics.

Individuals with maximum and minimum average bets

Despite high variability in relative bets among individuals, 19% of experiment subjects had an average bet of 1 i.e. placed only maximum bets. In Carrot treatment there were slightly more individuals with maximum bets accounting for 22% of all subjects in that treatment (Compared to 17% in Basic and 16% in Stick treatments). Placing maximum bets can be interpreted as being approximately risk-neutral and this behavior is typical for individuals who try to maximize their expected utility. Individuals with maximum bets in all rounds can be considered as rational from the point of view of statistics as there is positive expected value involved in the game. Because of this, individuals with average bet equal to one are analyzed as separate group. Majority of these individuals (83%) had maximum or minimum evaluation frequency (56% flipped one coin in each round and 27% flipped three coins in each round). However, there were relatively more individuals with maximum bets and one-coin option choices in Carrot treatment accounting for 9% of all individuals in that treatment (Compared to 4.7% in Basic and 1.4% in Stick treatments). Interestingly, from 136 males 22.8% had maximum bets in all rounds whereas corresponding figure for females is only 9.4% (From 64 females). This is another indication that men are more likely to behave in appliance with expected-utility maximization. Another group that can be treated separately consists of individuals with average bet close to 0 i.e. individuals who are highly risk-averse. However, there were only two individuals in Stick treatment with average bet equal or below 0.01 (Removed from following analysis).

Anomalously high bets with one-coin option in Carrot treatment can be partially explained by more expected-utility maximizers in this treatment (Individuals with average bet 1). When these individuals are removed from the analysis (11 individuals in Basic treatment, 15 individuals in Carrot treatment and 11 individuals in Stick treatment), difference between average bets with one-coin and three-coin options in Carrot treatment becomes statistically significant (0.34 vs. 0.43). Table 8 contains average bets of individuals when subjects with maximum bets are removed from the analysis and shows that MLA effect holds within this group as three-coin option bets are significantly higher than bets with one-coin option. Table 15 in Appendix 10 presents Mann-Whitney test statistics for this group. When running similar regression model as in Table 7 but with individuals placing maximum bets excluded, results show significant positive relationship between bet size and three-coin option choice in Carrot treatment (See Table 9).

Table 8: Bet size by coin flip option in separate treatments (Individuals with average bet 1 and below 0.01 excluded)

This table shows average bets of individuals in different treatments by coin flipping options with individuals with maximum and minimum bets in all rounds excluded. Carrot treatment includes bonuses for choosing "Flip 3 coins" options and Stick treatment includes fees for choosing "Flip 1 coin" options.

		By coin flip option		
	All coin flip options	**Flip 1**	**Flip 2**	**Flip 3**
All treatments				
Average	**0.35**	**0.32**	**0.37**	**0.38**
Median	0.23	0.19	0.27	0.27
Stdev.	0.32	0.32	0.31	0.32
Basic				
Average	**0.32**	**0.29**	**0.38**	**0.36**
Median	0.20	0.17	0.25	0.21
Stdev.	0.32	0.31	0.33	0.34
Carrot				
Average	**0.37**	**0.34**	**0.33**	**0.43**
Median	0.29	0.20	0.22	0.36
Stdev.	0.31	0.30	0.27	0.32
Stick				
Average	**0.35**	**0.35**	**0.36**	**0.33**
Median	0.25	0.20	0.30	0.25
Stdev.	0.31	0.33	0.30	0.29

One possible reason why individuals with maximum bets were not affected as predicted by bonuses provided in Carrot treatment could be that these bonuses were too low to be more attractive than higher investment flexibility. It is also possible that positive financial incentives in the form of bonuses caused an opposite reaction within subject group with high bets causing it to try to achieve better performance by choosing higher evaluation frequency. This possible reverse effect of financial incentives was discussed in hypothesis section in hypothesis H1. It implies that subjects react to bonuses with suspicion according to the logic that "there is no free lunch". As individuals with maximum bets are insensitive to bonuses which they see as implausibly small compared to expected gain from three consecutive coin flips with maximum bets they are also insensitive to reviewing frequency. Differences in average bets with different coin flip options in Stick treatment remain statistically insignificant although individuals with maximum bets are removed from the analysis. From this result I conclude that when individuals' evaluation frequency is manipulated by negative financial incentives in the form of fees MLA effect does not hold.

Table 9: Bet size and coin flip option choices (Individuals with average bet 1 and below 0.01 excluded)
The dependent variable is relative size. *Flip 1* and *Flip 3* are dummies for choosing to flip one or three coins respectively. *Male* is a dummy for gender and *Period* is a game period variable (periods 1-12). Carrot treatment includes bonuses for choosing "Flip 3 coins" options and Stick treatment includes fees for choosing "Flip 1 coin" options.

		By treatment		
	All	Basic	Carrot	Stick
Male	**0.09*** **	**0.10** **	**0.03**	**0.13*** **
	5.01	3.12	1.03	4.27
Flip 1	**-0.06** **	**-0.10** **	**0.00**	**-0.05**
	-2.75	-2.69	0.00	-1.28
Flip 3	**0.02**	**-0.02**	**0.14** **	**-0.03**
	0.97	-0.44	2.70	-0.63
Period	**0.03*** **	**0.02*** **	**0.04*** **	**0.03*** **
	11.39	5.61	7.92	6.80
Constant	**0.13*** **	**0.18*** **	**0.08**	**0.11* **
	4.88	3.84	1.41	2.41
Observations	1107	409	317	381
R squared	0.128	0.105	0.188	0.146
Significance F	0.000	0.000	0.000	0.000

*** Significant at 0.001 level, ** Significant at 0.01level, * Significant at 0.05 level.

5.6 Reactions to gains and losses

In the previous section I discussed effects of financial incentive manipulations on relative bet magnitude and evaluation frequency but it is also interesting to review how individuals react to gains and losses. By studying reactions to gains and losses I seek to better explain changes in individuals' risk-taking during 12 periods of the coin flipping game. This analysis is also interesting because Weber and Zuchel (2005) find that framing asset allocation situation as an investment portfolio results in individuals increasing risk-taking after losses more than after gains and I seek to confirm this finding.

First I analyzed reactions of individuals to gains and losses in all time periods (Table 10). I find that experiment subjects increased their bets with both gains and. However, individuals increased bets after losses to grater extent than after gains and the difference is statistically significant (See Wilcoxon signed rank test in Table 16 in Appendix 11). This result is in line with findings of Weber and Zuchel (2005) but to replicate their experiment more closely I analyzed initial and final bets of individuals separately. I find that a loss after initial bet results in slight increase in risk-taking and this result is statistically significant. On the other hand, a gain after initial bet does not show statistically significant change in bet size. Similar situation applies when final bets are analyzed but the increase in bet size after loss is significantly higher compared to reaction after initial bet.

Table 10: Bet change after gain or loss

This table shows average bets in two consecutive periods separately after gain and after loss. Average bets of two consecutive outcomes are presented for all periods, initial and final periods of the coin flipping game. Wilcoxon significance test for differences in average bets in two consecutive periods is presented in Table 16 in Appendix 11.

	After loss			After gain	
All periods					
Bet	Previous	Next	Bet	Previous	Next
Average	**0.46**	**0.53**	Average	**0.43**	**0.45**
Median	0.33	0.45	Median	0.29	0.33
Stdev.	0.38	0.39	Stdev.	0.36	0.37
Initial					
Bet	Initial	Next	Bet	Initial	Next
Average	**0.37**	**0.39**	Average	**0.38**	**0.41**
Median	0.20	0.21	Median	0.20	0.28
Stdev.	0.38	0.37	Stdev.	0.38	0.34
Final					
Bet	Previous	Final	Bet	Previous	Final
Average	**0.54**	**0.69**	Average	**0.49**	**0.54**
Median	0.47	1.00	Median	0.42	0.45
Stdev.	0.38	0.38	Stdev.	0.38	0.41

In their experimental setting Weber and Zuchel (2005) had only two periods and their findings are based on the reactions observed in these periods. I wanted to take this analysis one step further and analyze how two consecutive outcomes (gains and losses) influence individuals' risk-taking i.e. I analyze whether there are differences in reactions to two consecutive gains (losses) and two different outcomes e.g. gain after loss and loss after gain. Table 11 presents results for reactions to different outcomes and shows that risk-taking increased significantly after a loss with both previous gain and previous loss (The difference is not statistically significant). However, I find that although two consecutive gains result in a slight but statistically significant increase in bet size, the bet size is unchanged after a gain if there is previous loss. This finding suggests that risk-taking is increased after losses independent on previous gain or loss but is increased after multiple consecutive gains. This result is in appliance with escalation of commitment (Implying increased risk-taking after losses) but also partially in line with the house-money effect (implying increased risk-taking with gains) when there are multiple consecutive gains (See Table 17 in Appendix 11 for Wilcoxon test results).

Table 11: Bet change after consecutive gains or losses

This table shows average bets in two consecutive periods for all periods in the coin flipping game. Average bets of two consecutive periods are separated by two consecutive gains, two consecutive losses, gain after loss and loss after gain. Wilcoxon significance test for differences in average bets in two consecutive periods is presented in Table 17 in Appendix 11.

	After gain		**After loss**	
	(Previous gain)		**(Previous gain)**	
	Previous	Next	Previous	Next
Average	**0.42**	**0.45**	**0.45**	**0.53**
Median	0.30	0.35	0.35	0.46
Stdev.	0.35	0.37	0.37	0.38
	(Previous loss)		**(Previous loss)**	
	Previous	Next	Previous	Next
Average	**0.46**	**0.47**	**0.53**	**0.60**
Median	0.32	0.32	0.44	0.58
Stdev.	0.37	0.38	0.38	0.39

5.7 Double mental account theory: reactions to gains and losses

In the theory section I introduced a concept of double mental account approach which assumed presence of sensitivity to missed gains and saved losses. In this theory I hypothesized that individuals with lower portion invested in risky assets will decrease their investments to lower extent after a gain and increase it to lower extent after a loss compared to individuals with higher portion invested in risky assets. This is based on the assumption that after loss individuals with lower portion invested in risky assets view those assets that were not invested as saved losses, which are considered as gains in the omission account. On the other hand, if there is a gain, individuals with lower portion invested in risky assets view those assets that were not invested as missed gains, which are considered as losses on the omission account. To test for this theory I excluded in observations where bet size was unchanged in consecutive periods. After this I analyzed changes in observations where bets were reduced after a gain and increased after a loss. Table 12 shows bet change results when bet is reduced after a gain and increased after a loss. To make bet changes comparable (As individuals can only increase their bet to 1 and decrease it to 0) I adjusted bet changes by the maximum available change in that period i.e. when bet was increased (decreased) I calculated the relationship between actual bet increase (decrease) and maximum available bet increase (decrease). By using adjusted bet changes I was able to compare reactions to gains and losses of individuals with higher and lower bets.

Table 12: Double mental account theory: Differences between individuals with low and high bets
This table shows adjusted changes in bet size of individuals with above and below median bet size. Values are relative bet changes determined as bet change compared to maximum available bet change. These values represent portions of how much individuals increased (decreased) their bet compared to maximum available bet increase (decrease).

	After loss (When bet is increased)		**After gain** (When bet is decreased)	
	Bets below/equal to median	Bets above median	Bets below/equal to median	Bets above median
Average	**0.18**	**0.45**	**0.40**	**0.36**
Median	0.10	0.31	0.38	0.26
Stdev.	0.24	0.39	0.29	0.29

I find that individuals with bets higher than median increased their bet size after a loss to greater extent than individuals with lower than median bets when bet size was increased (The difference is statistically significant). I also find that individuals with lower than median bets decreased their bets to greater extent that individuals with above median bets but the difference is not statistically significant (Table 18 in Appendix 11). Based on these results I can confirm hypothesis H3 which states that magnitude of changes in risk-taking depends partially on portion of total wealth invested in risky assets. However, further research is needed to make more robust statements on whether portion of total available wealth is a relevant measure and whether it really affects sensitivity of individuals to gains and losses.

6. Conclusion

In my study I conducted a behavioural experiment related to myopic loss aversion, investment flexibility and the effect of financial incentives on evaluation frequency and risk-taking. I also analyzed reactions of individuals to single and consecutive gains and losses. Three separate treatments were applied, two of which were manipulated with financial incentives. Within Basic treatment with no manipulations MLA effect was strongly present and individuals with low evaluation frequency had significantly higher bets than individuals with higher evaluation frequency. This result is in line with earlier studies and the study by Fellner and Sutter (2009) who find that lower investment flexibility leads to higher risk taking. However, I find that although financial incentives were effective in lowering evaluation frequency, the MLA effect was weak or no longer observable in manipulated treatments as such. As a result of manipulation with positive financial incentives in the form of bonuses provided for infrequent evaluation options (Carrot treatment) individuals placed equally high bets with both frequent and infrequent evaluation frequency options. In the treatment with negative financial incentives in the form of fees charged for frequent evaluation (Stick treatment) differences in average bets with different evaluation frequency options were statistically insignificant. In addition, average bet size with low evaluation frequency option in Stick treatment was significantly lower than in other two treatments.

Anomalously high bets with high evaluation frequency in Carrot treatment can be partially explained by higher presence of individuals with maximum bets in all rounds. These individuals can be determined as expected-utility maximizers who are insensitive to gains and losses and I perform separate analysis where these individuals are excluded. When subjects with average bet equal to one are removed from the analysis, MLA effect is observed also in Carrot treatment and the difference in average bets with high and low evaluation frequency options is statistically significant. When analyzing the whole subject group, differences between average bets with low evaluation frequency option in Basic and Carrot treatments were not statistically significant suggesting that higher number of individuals choosing three-coin option in Carrot treatment did not reduce average bet with this option (Average bet with three-coin option is 0.56 in Basic and 0.54 in Carrot treatments). From these findings I can partially accept Hypothesis H1 and conclude that positive financial incentives can be effective and decrease evaluation frequency without reducing individuals' risk-taking. From practical point of view my findings can be interpreted as possibility to influence individuals' evaluation frequency and through that their risk-taking with bonuses or other positive financial incentives. These results do not support findings by Bashears et al. (2009) who find that financial incentives could be not effective in changing individuals framing and risk preferences.

I analyzed individuals' responses to gains and losses and my results are in line with findings of Weber and Zuchel (2005) who show that framing an experiment as an investment portfolio would result in higher risk-taking with losses than with gains. In addition, I find that individuals who received multiple (more than one) consecutive gains act in appliance with house-money effect and increase bet size with gains (The difference is statistically significant). On the other hand, receiving single gain after previous loss does not result in increased risk-taking.

In this paper I presented hypothetical dual mental account theory which considers sensitivity of individuals to missed gains and saved losses. According to this theory, individuals who have low portion of total wealth invested in risky assets increase their bet to lower extent after losses and reduce their investment to lower extent after gains compared to individuals with higher portion of total wealth invested in risky assets. I analyzed bet change differences between individuals with below and above median bets. I find partial support for my theory as individuals with below median bets increased their bets after losses to lower extent than individuals with above median bets. However, the difference in bet decrease after gains between individuals with below and above median bets was not statistically significant. According to these results, the extent to which individuals reduce or increase their investment after gains and losses is not only dependent on the position in the domain of gains or losses (Prospect theory) but also on the overall wealth available to invest. From practical point of view this could mean that individuals with moderate investment portions in riskier assets are more likely to maintain these portions with occurring gains and losses compared to individuals with large portions invested in risky assets.

In addition to tests on MLA and financial incentives I analyzed differences in risk-taking and evaluation frequency by gender, occupation and overconfidence. I find that overconfidence indicated by subjects estimating better than average performance is positively related to bet size and evaluation frequency i.e. individuals who believed that their final wealth would be higher than average placed significantly higher bets (around 10 percentage points) and reviewed their portfolios more frequently. However, only differences in bet size among overconfident and not overconfident individuals are statistically significant (Differences in evaluation frequency among overconfident and not overconfident subjects are not statistically significant). On the other hand, I did not find any relationship between overconfidence related to miscalibration of probabilities and bet size or evaluation frequency. Based on the abovementioned findings I have to reject hypothesis H2 stating that overconfident individuals will evaluate their portfolios more often.

I find that women placed significantly lower bets than men and evaluated their portfolios more frequently. However, the difference between evaluation frequencies of men and women is not statistically significant. Based on this result I have to reject hypothesis H4 from the part stating that females will evaluate their portfolios more often than males. When analyzing average bets by occupation I find that professionals placed significantly lower bets than students and the difference is statistically significant. Financial incentives seem to have affected all subject groups similarly and there were no significant differences in effectiveness of bonus or fee treatments on specific subject groups. However, treatments manipulated by financial incentives indicated reduced differences between evaluation frequency of men and women.

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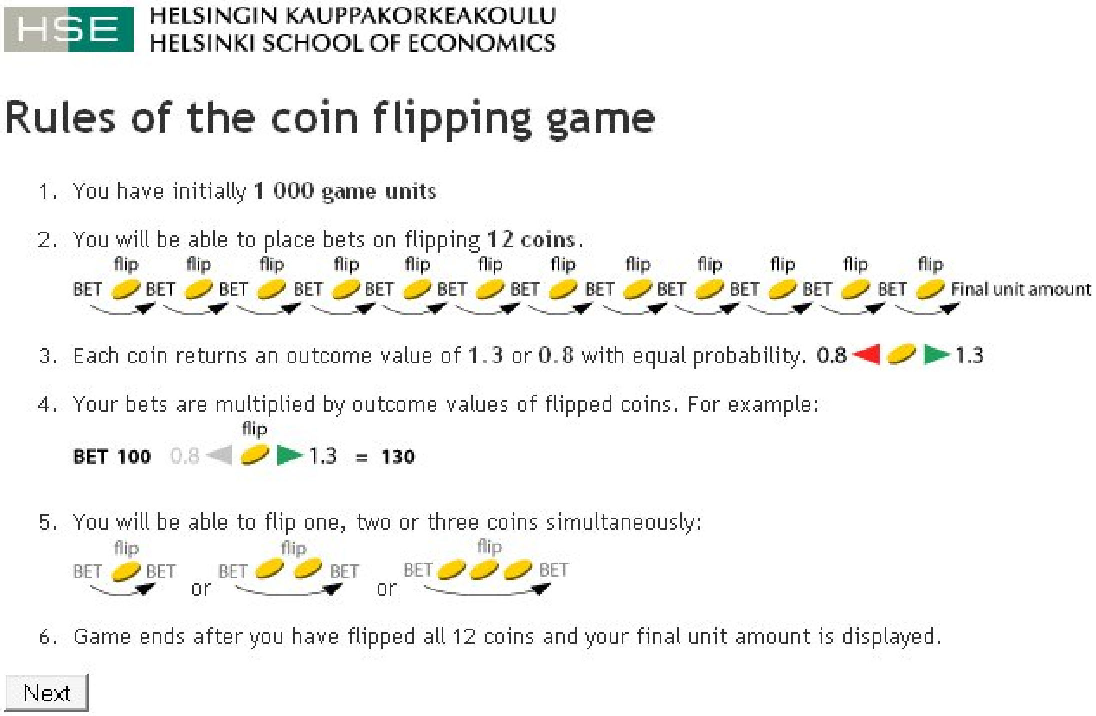
Appendix 1

Application phase containing rules of the game



HELSINGIN KAUPPAKORKEAKOULU
HELSINKI SCHOOL OF ECONOMICS

Rules of the coin flipping game

1. You have initially **1 000 game units**
2. You will be able to place bets on flipping **12 coins**.

3. Each coin returns an outcome value of **1.3** or **0.8** with equal probability. 0.8 1.3
4. Your bets are multiplied by outcome values of flipped coins. For example:

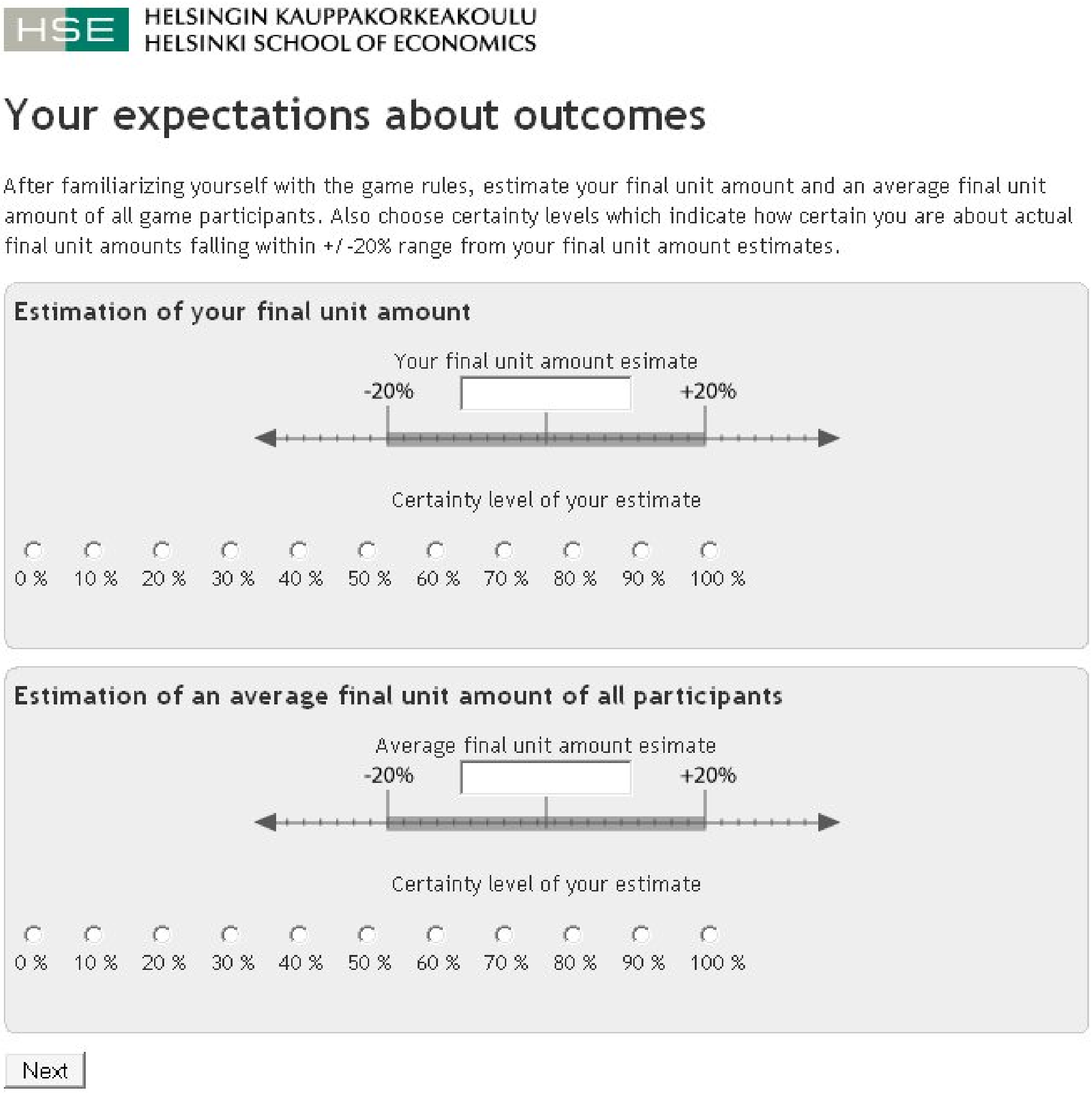
5. You will be able to flip one, two or three coins simultaneously:

6. Game ends after you have flipped all 12 coins and your final unit amount is displayed.

Next

Appendix 2

Application phase containing test for overconfidence



HELSINGIN KAUPPAKORKEAKOULU
HELSINKI SCHOOL OF ECONOMICS

Your expectations about outcomes

After familiarizing yourself with the game rules, estimate your final unit amount and an average final unit amount of all game participants. Also choose certainty levels which indicate how certain you are about actual final unit amounts falling within +/-20% range from your final unit amount estimates.

Estimation of your final unit amount

Your final unit amount esimate

-20% +20%

Certainty level of your estimate

0 % 10 % 20 % 30 % 40 % 50 % 60 % 70 % 80 % 90 % 100 %

Estimation of an average final unit amount of all participants

Average final unit amount esimate

-20% +20%

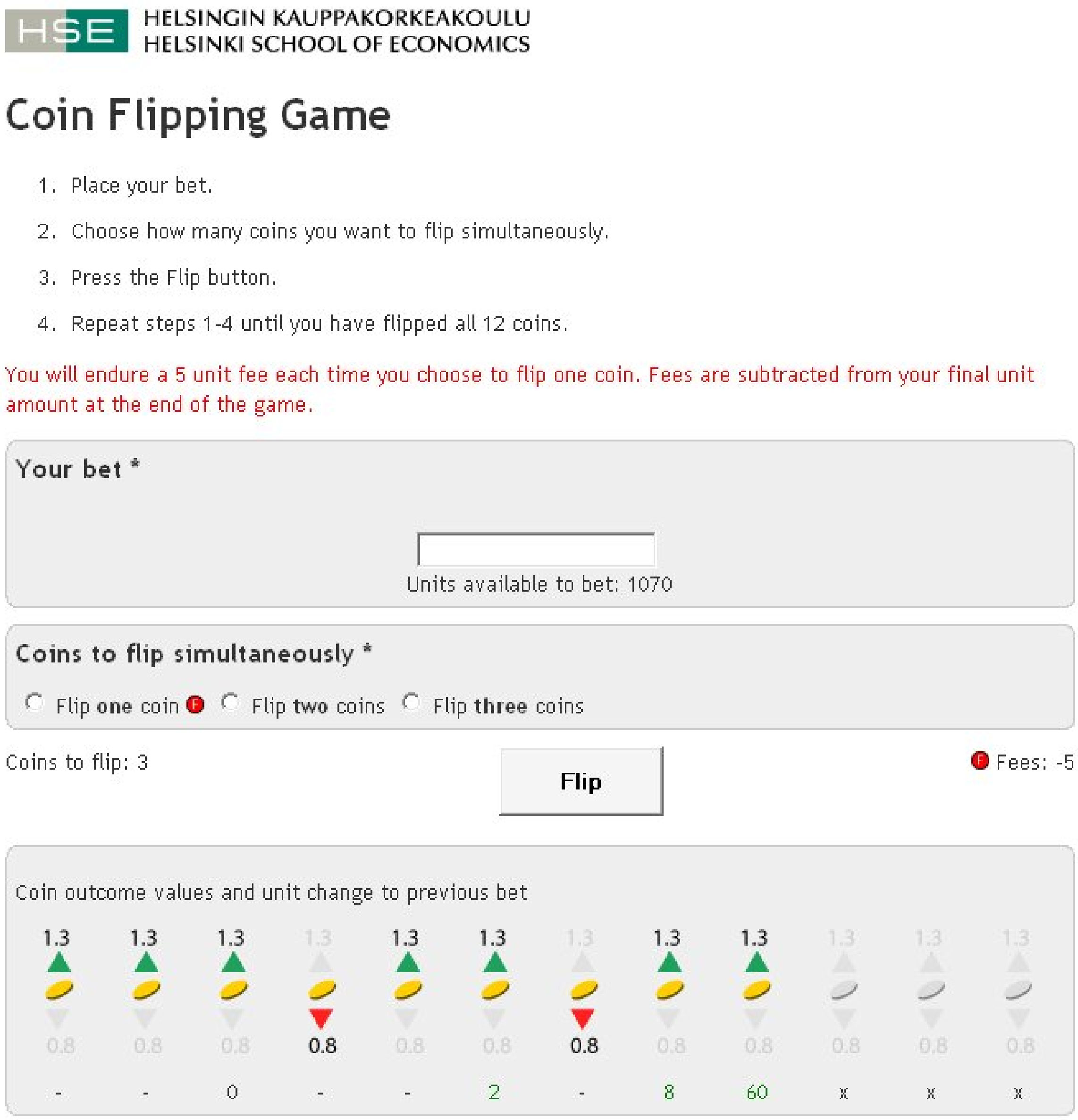
Certainty level of your estimate

0 % 10 % 20 % 30 % 40 % 50 % 60 % 70 % 80 % 90 % 100 %

Next

Appendix 3

Application phase containing coin flipping game (Stick treatment)



Appendix 4

Experiment invitation message

Dear recipient,

We are conducting an academic research project concerning financial decision-making. We invite you to participate in our research, which involves question sets and a coin flipping game.

In the coin flipping game you will be able to win real money (up to 50EUR) and receive your profits on personal bank account or donate them to charity. This research is conducted via internet application and will take you approximately 5-10min to complete.

To participate follow the link

http://www.xxxxx.fi/abramov/?code=xxxxxx

This invitation is active until xx.xx.xxxx.

Sincerely,

Professor Sami Torstila,
Professor Markku Kaustia,
Vladimir Abramov,

Helsinki School of Economics, Department of Finance and Accounting.

Appendix 5

Table 13: Mann-Whitney test for bet size and gender differences

This table shows Mann-Whitney non-parametric significance test results for differences in bet size of males and females with different coin flip options.

Male				**Female**			
Flip 1	x	x		**Flip 1**	x	x	
Flip 2		x	x	**Flip 2**		x	x
Flip 3	x		x	**Flip 3**	x		x
z	-2.81	1.30	-1.51	z	-1.56	-1.30	0.03
p (two-sided)	0.005	0.194	0.131	p (two-sided)	0.119	0.194	0.976

All coin flip options	
z	6.20
p (two-sided)	0.000

Table 14: Bet size and overconfidence (type 2)

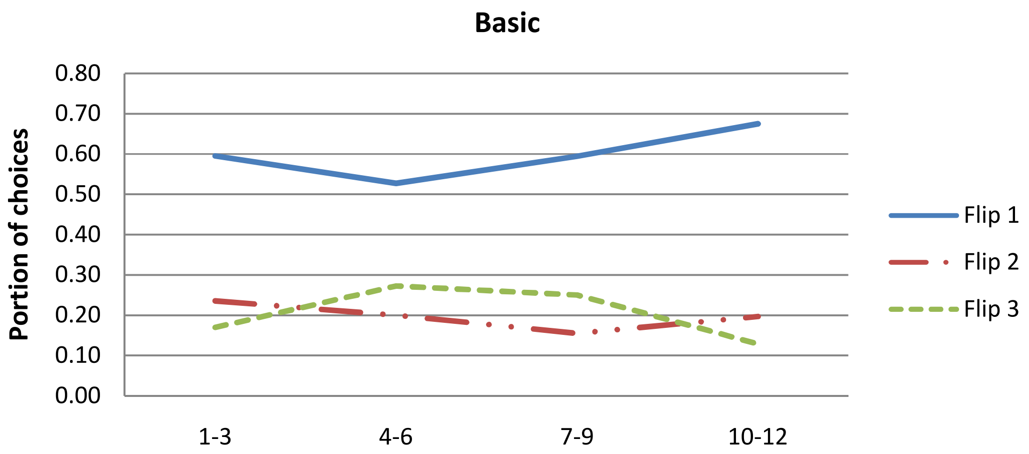
This table shows average bets of overconfident and not overconfident individuals by treatment. This table also contains Mann-Whitney test results for differences in bets of overconfident and not overconfident individuals. Carrot treatment includes bonuses for choosing "Flip 3 coins" options and Stick treatment includes fees for choosing "Flip 1 coin" options. Overconfidence type 2 is related to individuals who believe in better than average performance.

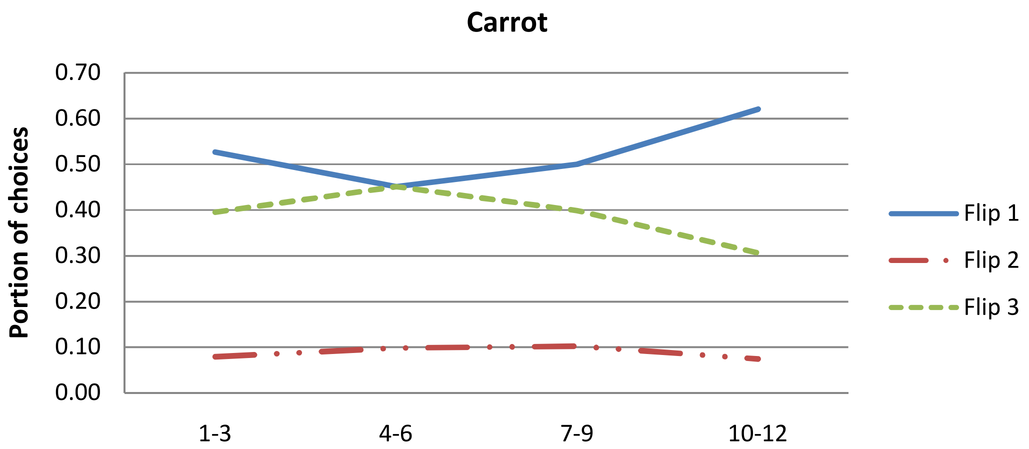
	Overconfident (type 2)			
	Yes	**No**	Mann-Whitney test	
All treatments				
Average	**0.55**	**0.43**	z	-4.87
Median	0.47	0.29	p (two-sided)	0.000
Stdev.	0.39	0.38		
Basic				
Average	**0.46**	**0.41**	z	-0.75
Median	0.33	0.23	p (two-sided)	0.453
Stdev.	0.40	0.37		
Carrot				
Average	**0.61**	**0.52**	z	-2.42
Median	0.56	0.44	p (two-sided)	0.016
Stdev.	0.37	0.38		
Stick				
Average	**0.60**	**0.39**	z	-5.31
Median	0.53	0.25	p (two-sided)	0.000
Stdev.	0.37	0.37		

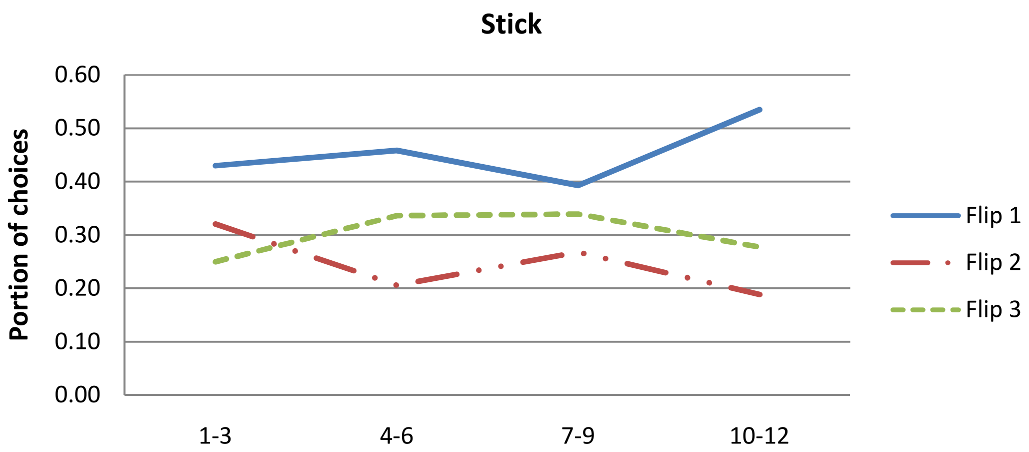
Appendix 6

Chart 2: Relative number of coin flip choices by treatment (Periods 1-12)

This chart illustrates development of relative number of coin flip choices by period in Basic, Carrot and Stick treatments. Carrot treatment includes bonuses for choosing "Flip 3 coins" options and Stick treatment includes fees for choosing "Flip 1 coin" options.







Appendix 7

Table 15: Mann-Whitney test for bets with different coin flip options

This table shows Mann-Whitney non-parametric significance test results for differences in bets with different coin flip option in different treatments. Carrot treatment includes bonuses for choosing "Flip 3 coins" options and Stick treatment includes fees for choosing "Flip 1 coin" options.

Within treatments

Basic			
Flip 1	x	x	
Flip 2		x	x
Flip 3	x		x
z	-3.78	-1.10	-2.64
p (two-sided)	0.000	0.271	0.008

Carrot			
Flip 1	x	x	
Flip 2		x	x
Flip 3	x		x
z	0.58	2.97	-3.07
p (two-sided)	0.562	0.003	0.002

Stick			
Flip 1	x	x	
Flip 2		x	x
Flip 3	x		x
z	-1.44	-1.32	0.05
p (two-sided)	0.150	0.187	0.960

Across treatments

Flip 1			
Basic	x	x	
Carrot		x	x
Stick	x		x
z	-1.21	-5.67	4.13
p (two-sided)	0.226	0.000	0.000

Flip 2			
Basic	x	x	
Carrot		x	x
Stick	x		x
z	-1.20	0.49	-1.42
p (two-sided)	0.230	0.624	0.156

Flip 3			
Basic	x	x	
Carrot		x	x
Stick	x		x
z	1.35	0.07	2.18
p (two-sided)	0.177	0.944	0.029

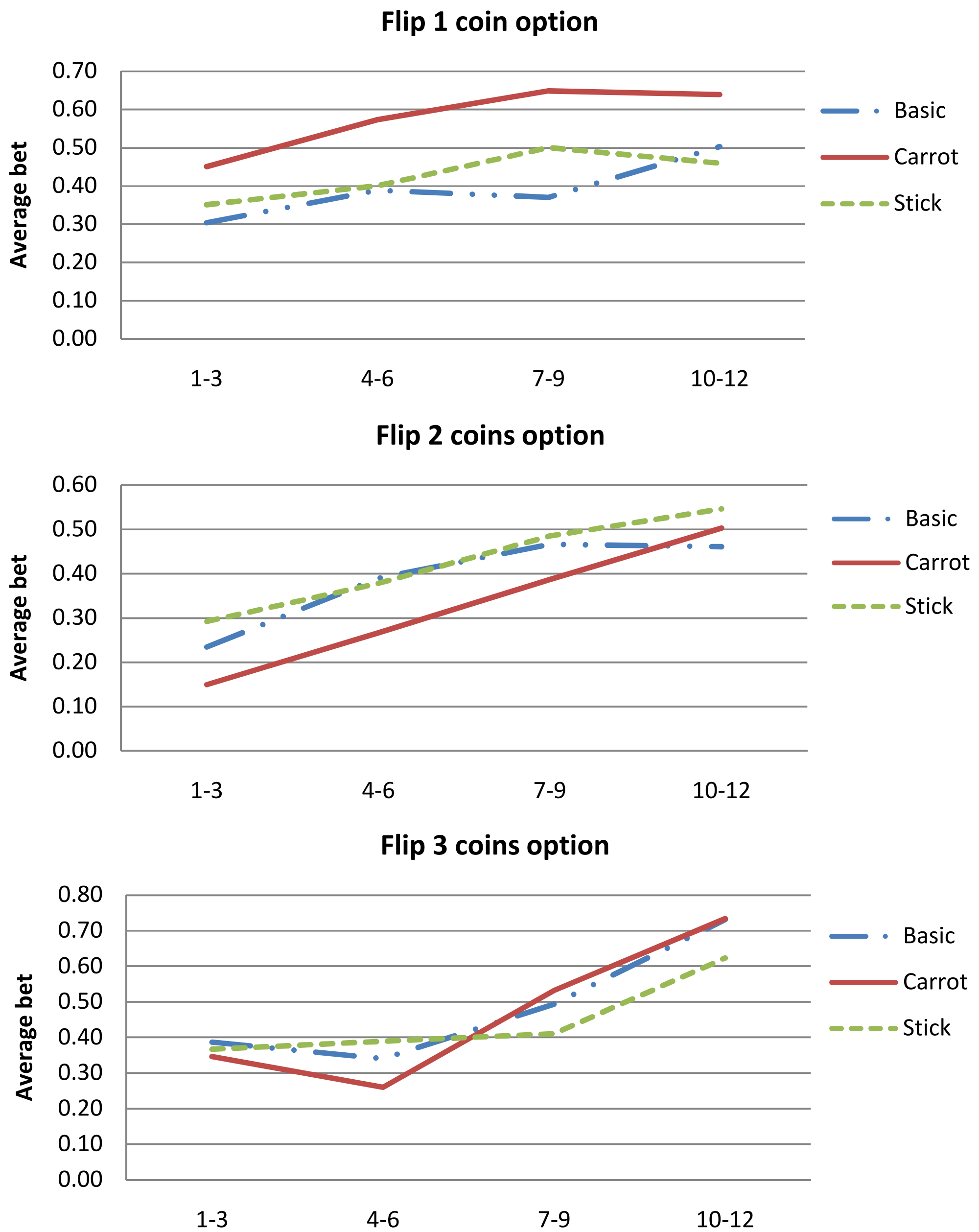
All coin flip options			
Basic	x	x	
Carrot		x	x
Stick	x		x
z	-1.2	-5.19	4.06
p (two-sided)	0.230	0.000	0.000

All treatments			
Flip 1	x	x	
Flip 2		x	x
Flip 3	x		x
z	-3.22	0.35	-3.35
p (two-sided)	0.001	0.726	0.001

Appendix 8

Chart 3: Average bets by coin flip option (Periods 1-12)

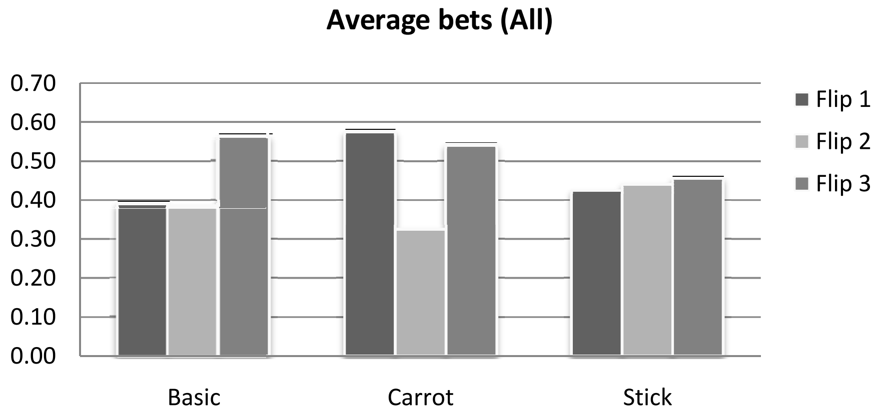
This chart shows average bet amounts by coin flip option during 12-period coin flipping game. Carrot treatment includes bonuses for choosing “Flip 3 coins” options and Stick treatment includes fees for choosing “Flip 1 coin” options.

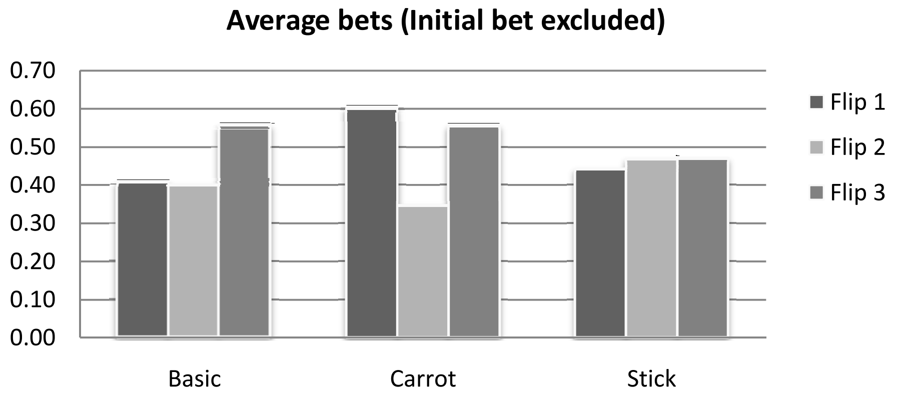


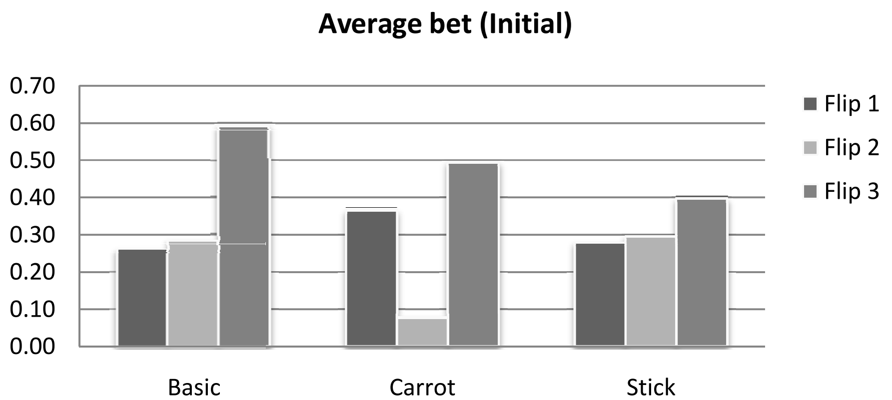
Appendix 9

Chart 4: Average bet among treatments

This chart shows average bets with different evaluation frequency options among separate treatments. Initial bet and following bets are presented separately to display changes in bet size which occur during time periods. Average bets by period are presented in Chart 6 in Appendix 8. Carrot treatment includes bonuses for choosing "Flip 3 coins" options and Stick treatment includes fees for choosing "Flip 1 coin" options.







Appendix 10

Table 15: Mann-Whitney test for bets with different coin flip options (Individuals with average bet 1 and below 0.01 excluded)

This table shows Mann-Whitney non-parametric significance test results for differences in bets with different coin flip option in different treatments. Carrot treatment includes bonuses for choosing "Flip 3 coins" options and Stick treatment includes fees for choosing "Flip 1 coin" options.

Within treatments

Basic			
Flip 1	x	x	
Flip 2		x	x
Flip 3	x		x
z	-1.89	-3.18	0.84
p (two-sided)	0.059	0.002	0.401

Carrot			
Flip 1	x	x	
Flip 2		x	x
Flip 3	x		x
z	-2.88	-0.35	-1.66
p (two-sided)	0.004	0.726	0.097

Stick			
Flip 1	x	x	
Flip 2		x	x
Flip 3	x		x
z	-0.44	-1.41	1.11
p (two-sided)	0.660	0.159	0.267

Across treatments

Flip 1			
Basic	x	x	
Carrot		x	x
Stick	x		x
z	-2.21	-2.65	0.47
p (two-sided)	0.027	0.008	0.638

Flip 2			
Basic	x	x	
Carrot		x	x
Stick	x		x
z	-0.04	0.51	-0.55
p (two-sided)	0.968	0.610	0.582

Flip 3			
Basic	x	x	
Carrot		x	x
Stick	x		x
z	-0.32	-2.08	2.74
p (two-sided)	0.749	0.038	0.006

All coin flip options			
Basic	x	x	
Carrot		x	x
Stick	x		x
z	-2.04	-3.47	1.55
p (two-sided)	0.041	0.001	0.121

All treatments			
Flip 1	x	x	
Flip 2		x	x
Flip 3	x		x
z	-3.72	-3.26	-0.26
p (two-sided)	0.000	0.001	0.795

Appendix 11

Table 16: Wilcoxon signed rank test for bet change after gain or loss

This table shows Wilcoxon signed rank non-parametric significance test results for differences in two consecutive periods separately after gains and losses in all periods, initial and final periods.

	After loss	After gain
All periods		
z	-9.83	-2.84
p (two-sided)	0.000	0.005
Initial		
z	-3.26	-1.59
p (two-sided)	0.001	0.112
Final		
z	-5.55	-1.18
p (two-sided)	0.000	0.238

Table17: Wilcoxon signed rank test for bet change after consecutive gains and losses

This table shows Wilcoxon signed rank non-parametric significance test results for differences in two consecutive periods separately after two consecutive gains, two consecutive losses, gain after loss and loss after gain.

	After loss	After gain
(Previous gain)		
z	-7.36	-2.50
p (two-sided)	0.000	0.012
(Previous loss)		
z	-5.95	-0.64
p (two-sided)	0.000	0.522

Table 18: Double mental account theory significance tests

This table shows t-test and Mann-Whitney test results for differences in adjusted changes in bet size of individuals with above and below median bet size.

	After loss (When bet is increased)	**After gain** (When bet is decreased)
t-test		
t	-6.91	0.80
p (two-sided)	0.000	0.427
Mann-Whitney test		
z	-6.42	0.47
p (two-sided)	0.000	0.638

Appendix 12

Figure 6: Binomial lattice of the coin flipping game

t0	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10	t11	t12
												23298
											17922	0.02%
										13786	0.05%	**14337**
									10604	0.10%	**11029**	0.29%
								8157	0.20%	**8484**	0.54%	**8823**
							6275	0.39%	**6526**	0.98%	**6787**	1.61%
						4827	0.78%	**5020**	1.76%	**5221**	2.69%	**5430**
					3713	1.56%	**3861**	3.13%	**4016**	4.39%	**4177**	5.37%
				2856	3.13%	**2970**	5.47%	**3089**	7.03%	**3213**	8.06%	**3341**
			2197	6.25%	**2285**	9.38%	**2376**	10.94%	**2471**	11.72%	**2570**	12.08%
		1690	12.50%	**1758**	15.63%	**1828**	16.41%	**1901**	16.41%	**1977**	16.11%	**2056**
	1300	25.00%	**1352**	25.00%	**1406**	23.44%	**1462**	21.88%	**1521**	20.51%	**1582**	19.34%
1000	50.00%	**1040**	37.50%	**1082**	31.25%	**1125**	27.34%	**1170**	24.61%	**1217**	22.56%	**1265**
100%	**800**	50.00%	**832**	37.50%	**865**	31.25%	**900**	27.34%	**936**	24.61%	**973**	22.56%
	50.00%	**640**	37.50%	**666**	31.25%	**692**	27.34%	**720**	24.61%	**749**	22.56%	**779**
		25.00%	**512**	25.00%	**532**	23.44%	**554**	21.88%	**576**	20.51%	**599**	19.34%
			12.50%	**410**	15.63%	**426**	16.41%	**443**	16.41%	**461**	16.11%	**479**
				6.25%	**328**	9.38%	**341**	10.94%	**354**	11.72%	**369**	12.08%
					3.13%	**262**	5.47%	**273**	7.03%	**284**	8.06%	**295**
						1.56%	**210**	3.13%	**218**	4.39%	**227**	5.37%
							0.78%	**168**	1.76%	**174**	2.69%	**181**
								0.39%	**134**	0.98%	**140**	1.61%
									0.20%	**107**	0.54%	**112**
										0.10%	**86**	0.29%
											0.05%	**69**
												0.02%

This figure illustrates the binomial lattice of the coin flipping game with corresponding probabilities (%) and possible returns on maximum bet size (bolded). These probabilities are not shown to the game participants.