



Why does the Allais paradox occur also among business students?

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Abstract

The reasons for people making certain decisions has always been a question of interest among researchers. This paper presents a broad study in the field of Behavioral Finance on the topic of the Theory of Rational Choice under uncertainty. The main focus of this paper is to examine the factors which cause violation of one of the rational choice axioms – the independence axiom, also known as Allais paradox, among NHH (Norwegian School of Economics) Master's students. The study discusses the theoretical and empirical significance of variables like gender, age, previous negative experience, financial obligations and the major profile in Master's program in the decision making of students taking Master's degree at NHH (Norwegian School of Economics). The key question which is examined throughout the whole research is what characteristics does the individual who is more likely to violate the independence axiom have. For the empirical study the logit model has been selected in order to provide the analysis on the probability of the responsiveness to the Allais paradox of an individual with certain characteristics. The responsiveness to the Allais paradox is examined by two lotteries: a lottery with potential gain and a lottery with potential loss outcomes. Each lottery is also examined by two regression models: first, the model which highlights the significance of gender and age in the decision making, and second, the expanded model which, additionally, examines the significance of previous negative experience, financial obligations and the major profile in studies on the responsiveness to the Allais paradox. The empirical study shows the significance of gender and age of the respondent on his/her responsiveness to Allais paradox in the basic model for the lottery with potential gain outcome. The expanded model has confirmed the link between the violation of independence axiom and the gender in the lottery with potential gain outcome. Additionally, the importance of experience and major in the studies has been confirmed. The study has also found the significant effect of age on the decision making in the basic model of the lottery with potential loss outcome and confirmed the importance of experience, financial obligations and major in studies in the expanded model for the lottery with potential loss outcome.

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1. Introduction

Rational choice is one of the most important concepts that can be connected with any field in business. “It is irrational!” is often heard on different occasions. Who is more likely to make less rational decisions under uncertainty? Are they men or women? What other characteristics do people that make irrational decisions have?

The purpose of this study is to define characteristics of an individual that is probably more likely to violate the axioms of the Rational Choice Theory. The focus of this study is to examine the Master’s students at NHH (Norwegian School of Economics) and their decision making. This paper emphasizes a particular contradiction to the theory, namely the violation of the independence axiom, which is also known as Allais paradox. The study illustrates analysis over a sample of Master’s students that bear a common business education background, with some other characteristics being different between individuals. Therefore, the paper contributes to the development on the topic of Allais paradox by adding numerous variables which have not been widely investigated in the academic world.

In the first part of the paper, basic theoretical concepts are discussed. The Rational Choice theory and Rational Decision Making axioms are explained and the Expected Utility Theorem is illustrated. Moreover, the basic concept of the Allais paradox, which is the main topic of the paper is clarified. These concepts serve as a foundation for understanding the topic as well as become the ground for future discussions.

In the second part of the paper, the empirical background from various fields is used to illustrate the importance of the proposed variables for the research. Moreover, certain variables which have been selected for the study are found to contradict some of the arguments discussed in the academic world before. Therefore, both sides of the coin are observed.

Next, the paper illustrates the techniques and methods used and assumption made for building the reliable model for the empirical study. In order to examine the responsiveness to Allais paradox among NHH- Norwegian School of Economics Master’s students, cross-section data is obtained. Moreover, the model and variable selection diagnostics are performed in order to avoid lack of fit, misspecification of variables, collinearity and multicollinearity and other problems.

The following part deals with the empirical study of the obtained data within the selected estimation models. Due to the logit model being selected the most suitable regression model

for the empirical study, the marginal effect of the explanatory variables is estimated. This gives an opportunity to observe the change in probability of the responsiveness to the Allais paradox given the characteristics of the respondent. Moreover, the empirical study captures the responsiveness to the Allais paradox in two different lotteries, the lottery with potential gain outcome and the lottery with potential loss outcome, as well as, estimates the effect of explanatory variables on the responsiveness to the Allais paradox in two different models. First model investigates the contribution of gender and age factors to the violation of the independence axiom. The expanded regression model adds the effect of the financial obligations, negative experience and the major within the Master studies to the investigation of responsiveness to the Allais paradox.

The paper continues with the discussion, providing critical arguments for the obtained statistical results. The discussion summarizes the key findings from two lotteries and two regression models estimated for each lottery. Additionally, this paper highlights the limitations of the study and provides notes on future development of the topic.

The paper ends with a conclusion which summarizes the topic of the paper and key findings of the study.

2. Theoretical background

In this section the main theories and concepts and their importance in the research are explained. The theories and concepts discussed in this part will become the basis for the following analysis.

2.1 Rational Choice Theory

First, let us look carefully at the origin of the decision making and rational choice. Decision, according to Business dictionary, is a choice between alternative actions/lotteries in a situation of uncertainty (Businessdictionary, 2017). In this paper a definition of a lottery by von Neumann & Morgenstern (1944) is considered. According to them, “a lottery is the probability distributed over a certain set of prizes or outcomes”.

The topic of decision making is widely discussed. The most important assumption from the Rational Choice Theory is that the individual attempts to obtain the maximum utility from the decision based on his/her preferences (von Neumann & Morgenstern, 1944; Savage, 1954; Jeffrey, 1990). Despite the clear explanation of the concept of the rational choice, the perspective of revealed preferences is not shared by all academics. Some scientists within the field of behavioral finance claim that irrational choice of a decision maker is based on the biases that influence the decision, thus the decision does not truly reveal the preference of the actor (Kahneman & Tversky, 1984; Hens & Bachmann, 2012). Others found that utility is the measure that can only be inferred from the choices, making the process of maximizing the utility more complex (Herrnstein, 1990). The idea of revealed preference goes back to Paul Samuelson who presented that revealed preferences can be basis for the Theory of Consumer Behaviour (Samuelson, 1938; Samuelson, 1948). Therefore, the perception of utility and rationality is rather unique. In this paper, a decision maker who chooses lottery A over lottery B, basing his/her decision on higher expected utility from lottery A, is an expected utility maximizer, and, thus, considered to behave rationally. Moreover, within this research, the decision can be called rational only if it does not violate the Rational Choice Preference axioms.

The main reason for the Rational Choice Theory to be the basis for this research is the simplicity of the theory in common sense: many theories need more information about the lottery than the outcomes or utility from the outcomes, whereas Rational Choice Theory makes the rationality of the choice self-explanatory.

2.2 Preference Axioms

In their book “Theory of Games and Economic Behavior” (1944) von Neumann and Morgenstern note the importance of the preference axioms which make the utility function exist. First, the Rational Choice Theory assumes the *completeness axiom*, which states that in a fixed set of lotteries $A = \{X_1, \dots, X_n\}$, the decision maker has to be able to make a weak ordering for all lotteries (Roeser et al., 2012). It means that the decision maker has to prioritize one of the lotteries or express indifference between them.

$$X_i \succcurlyeq X_j \text{ or } X_j \succcurlyeq X_i \quad (1)$$

for all X_i and X_j in a set A .

Transitivity axiom states that in case of three lotteries if a lottery “i” is preferred to the lottery “j”, and lottery “j” is preferred to the lottery “k”, it is right to say that the decision maker, therefore, also prefers lottery “i” to the lottery “k” in a fixed set A (Kahneman & Tversky, 1986; Regenwetter, Dana & Davis-Stober, 2011).

$$X_i \succ X_j \text{ and } X_j \succ X_k, \text{ then } X_i \succ X_k \quad (2)$$

for all X_i , X_j and X_k in a set A .

Together the assumption of *transitivity* and *completeness* ensure that the decision maker is able to make weak-ordering of the lotteries. The next assumption of the Rational Choice Theory assumes that the decision maker has a set of the *probabilistic beliefs*. It is considered that the probability associated with each lottery in the fixed set A is presented by probability function p , which satisfies the following assumptions. First, for any outcome x within the lottery, the probability of the outcome lies in the interval from 0 to 1. Second, if the outcome x is certain, the probability of the lottery is equal to 1. Third, if the outcomes are mutually exclusive, then the probability of any of them is the sum of probabilities of both outcomes within the lottery. Finally, in case of two outcomes, the probability of both outcomes simultaneously is the conjunction of the probabilities of the outcomes given that one of the outcomes is true (Milgrom & Levin, 2004).

The third axiom of Rational Choice Theory is *independence axiom*, which states that if there is an identical part of the lottery, the decision has to be made based only on differentiating part of the lottery (Hens & Bachmann, 2012). This can be illustrated as following:

$$X_i > X_j, \text{ then } (X_i, p; X_k, 1 - p) > (X_j, p; X_k, 1 - p) \quad (3)$$

where X_i, X_j and X_k are the outcomes and p is the probability of the outcome in the lottery.

Nevertheless, all assumptions are important for the Rational Choice Theory to hold, in this research weak-ordering and probability assumptions are assumed to hold. This can be associated with the belief in ability of students with business education background to demonstrate weak-ordering of preference as well as have basic knowledge about probability distribution. However, the independence axiom has a significant role in the study. Von Neumann and Morgenstern (1944) in their book note that independence axiom is the most important assumption of Rational Choice Theory, meaning that that the violation of the axiom will indicate that the action made by decision maker can be considered as irrational behavior and factors contributing to the irrational behavior need to be analyzed. Thus, the focus throughout the research is mainly made on the independence axiom.

2.3 Expected Utility Theorem

Expected Utility Theorem has a long history. First, the basic concept of Expected Value was illustrated by Blaise Pascal in 1670. He examined the gain and the loss that experiences an individual by believing in or denying the existence of the God. Pascal has found that the expected value of an event can be defined as summation of weighted probabilities multiplied by the outcome (Hacking, 1972).

$$E(x) = p_1x_1 + p_2x_2 + \dots + p_nx_n = \sum_{i=1}^n p_i x_i \quad (4)$$

In 1738 Daniel Bernoulli has proposed a new concept of Expected Utility. Bernoulli has found an inverse relationship between the marginal utility of the lottery and wealth (Stearns, 2000). However, the modern look of the Expected Utility Theorem was proposed by von Neumann and Morgenstern (1944) who illustrated utility as a function over gambles and lotteries.

$$EU(x) = p_1u(x_1) + p_2u(x_2) + \dots + p_nu(x_n) = \sum_{i=1}^n p_i u(x_i) \quad (5)$$

The equation 5 illustrates that the expected utility of a lottery can be calculated as summation of weighted probabilities of an outcome multiplied by the utility obtained from the outcome. The utility function has property of an expected utility function only if the equation 5 holds for the set X with outcome x_i and probabilities p_i (Fonseca, 2009).

2.4 Allais paradox

Allais paradox is an illustration of inconsistency of an individual in the decision making associated with how the chances of lotteries are framed (Allais, 1953; Kahneman & Tversky, 1981; Kahneman & Tversky, 1984).

Allais has presented the paradox by assuming two hypothetical lotteries. First, the decision maker was given a lottery with the alternatives:

Alternative A: receiving \$ 3000 with probability of 100%.

Alternative B: 80% chance of receiving \$ 4000; 20% chance of getting nothing.

Then, the same decision maker was asked to participate in a lottery with the following two options:

Alternative A': 10% chance of winning \$ 3000; winning nothing with probability of 90%.

Alternative B': 8% probability of winning \$ 4000; 92% chance of getting nothing.

The Expected Utility Theorem suggests that the expected utility maximizer should choose the lottery which gives the greatest utility to the decision maker. Most people when they are given a lottery with sure alternative (alternative A) and uncertain outcome choose sure alternative. This can be explained that the decision maker is choosing the sure alternative because it creates greater utility, even though the expected value of alternative B is greater. Moreover, if the decision maker prefers alternative A to alternative B, alternative A' is also preferred to alternative B'. The combination of choices AB' or BA' is counted as a violation of independence axiom and thus, a violation of Rational Choice Theory, but it is quite often the case (Kahneman & Tversky, 1979). Why is it considered as violation?

By selecting alternatives decision maker suggests that chosen alternatives create the maximum utility. The expected utility of the lotteries are as follows:

*Alternative A: $1 * u(3000)$*

*Alternative B: $0.8 * u(4000) + 0.2 * u(0)$*

Thus, by selecting Alternative A, the decision maker suggests the inequality:

$1 * u(3000) > 0.8 * u(4000)$. However, the choice between alternative A' and B' is not that clear.

The probabilities suggest the following:

$$\text{Alternative } A': 0.1 * u(3000) + 0.9 * u(0)$$

$$\text{Alternative } B': 0.08 * u(4000) + 0.92 * u(0)$$

In this situation the same individual in most of the cases tends to select alternative B'. The reason for it is quite straight-forward. In a lottery with potential gain outcome, if the chances of winning are small in both alternatives, then the difference between choosing 10% chance or 8% is not crucial. That is the reason why most of the decision makers intuitively tend to select alternative B', which is a violation of the independence axiom if in the first set of the lottery alternative A is chosen. The violation can be explained by the common component in the alternative A and B, which is eliminated in the alternative A' and alternative B' (Hens & Bachmann, 2012). The common part of the lottery, according to the independence axiom, has to be ignored when making the choice.

$$\text{Alternative } A': 0.1 * u(3000) + 0.9 * u(0) = 1 * u(3000)$$

$$\text{Alternative } B': 0.08 * u(4000) + 0.9 * u(0) + 0.02 * u(0) = 0.8 * u(4000) + 0.2 * u(0)$$

After ignoring the *common sequence* of 0.9 probability of winning 0 in both alternatives and normalizing alternatives with multiplying them by 10 (*common ratio*), we can clearly see that the alternatives A' and B' have the same form as alternatives A and B. By selecting alternative B', decision maker states: $0.1 * u(3000) < 0.08 * u(4000)$. Thus, the decision maker contradicts her/his own rationality in decision making, because before his/her beliefs were: $1 * u(3000) > 0.8 * u(4000)$.

The example of Allais paradox shows the violation of the independence axiom which is the key axiom which must be satisfied in order for the Expected Utility Theorem to hold. This paper aims to examine which characteristics does the individual who is more likely to violate the independence axiom have.

3. Empirical background

The topic of the Allais paradox is widely discussed in academic world. Papers by Allais (1953) and Kahneman & Tversky (1981) present basic evidence that people tend to violate the independence axiom due to the willingness of pursuing the greatest value in absolute outcome from the lottery. The problem related to the situation is that the greatest expected value does not always bring the greatest expected utility. The important question which is addressed in this part of the paper, is to present some influential papers and indicate factors which have the greatest effect on the decision making under uncertainty.

The importance of gender in decision making under uncertainty is thoroughly discussed in a large number of papers. Despite the progressing tendency to have equal rights and attitude to both genders, there is evidence that the decision making is strongly correlated with the psychological perspective of the human being (Croson & Gneezy, 2009). Hucks and Muller (2012) in their research discuss the factors that make people violate the axioms of Rational Choice and conclude that women tend to violate the axioms of Rational Choice Theory more often than men. The reason for women to behave this way can be explained by women's pessimistic and insensitive attitude to the decision making under uncertainty (Byrnes, Miller & Schafer, 1999). Moreover, psychological factors were indicated to contribute to the investment behavior of women. Weber, Blais & Betz (2002) in their work have presented evidence on risk attitude within Expected Utility framework, and found that women are less likely to be engaged in risky lotteries compared to men. Barber and Odean (2001) present alternative explanation of the behavior and highlight the importance of self-confidence in decision making under uncertainty. Men are feeling more confident than women in their decisions and, thus, are more likely to choose risky alternatives in the lottery considering them as a call for action, whereas women treat it as a danger and choose to avoid such lottery (Arch, 1993). Thus, numerous academic papers note that women tend to choose safer investment option guided by the psychological factors of human being. However, does that mean that men are more rational in their decision making because of their self-confidence? Men tend to overestimate the alternative and as a result face overtrading and lower returns (Da Costa Jr, Mineto & Da Silva, 2008). Therefore, overconfidence in decision making can lead to less rational behavior. Today the question of what contributes to less rational behavior, the overconfidence (men), or fear and pessimism (women), in decision making is still open. In this paper the link between rational behavior and gender is examined. Moreover, the role of the variable in this research is to

discover whether the society is proceeding with modern feminist flow within the sample. In other words, whether women can compete with men in rationality of their decision making.

Another factor that is often mentioned to have significant effect on decision making is age. The assumption that rationality improves with age is highly discussed in the academics. A number of papers present evidence of improvements in cognitive capacities and reasoning skills correlated with age (DeLoache, Miller & Pierroutsakos, 1998; Mandler & McDonough, 1998). This can be explained by the increase in rationality associated with improved ability of emotional regulation skill and more efficient strategies applied for decision making. Moreover, a number of papers discuss speed of processing and superior memory strategies as an input for rational decision making (Kail & Salthouse, 1994; Schneider & Bjorklund, 1998; Ornstein, Haden & Hedrick, 2004). Thus, improved decision making qualities correlated with aging lead to more rational choice. On the other side, Reyna & Farley (2006) and Mather et al. (2012) papers illustrate the tendency of older individuals choosing the safe alternative even if the expected utility from the alternative is lower than the expected utility from choosing the risky option, and, thus, illustrating the violation of Expected Utility Theorem. The stereotype that older people tend to choose safe alternatives under their decision making or hold less proportion of risky assets is also often discussed in academic world (Okun, 1976; McInish, 1982; Morin & Suarez, 1983; Heckhausen, Dixon, & Baltes, 1989; Palsson, 1996; Halek & Eisenhauer, 2001; Hunter & Kemp, 2004; Jianakoplos & Bernasek, 2006). However, research found that the behavior varies depending on situation. Older individuals choose sure outcome in a lottery with two potential losses, and tend to select riskier alternative in a lottery with two potential gains (Lauriola & Levin, 2001; Deakin, Aitken, Robbins & Sahakian, 2004; Mather et al., 2012). Considerably innovative is the model presented by Tymula et al. (2013) paper which illustrates an implication that the rationality has inverted U - shape in Age, thus, individuals in their adolescence and elderly individuals tend to violate Expected Utility Theorem more often compared with adults in their mid-twenties. Authors have found that adults in their mid-twenties find the ambitious lotteries less attractive, whereas older adults and adolescents find them tolerable. In this paper, it is important to remember that variable Age is not a proxy for experience, IQ or level of education. It represents behavioral/psychological aging of an individual in decision making which could be influenced by the change in brain activity, self-esteem etc. Moreover, due to small sample size of this research, the importance of the variable is to show whether there is an effect of age on decision making in general, and what is the marginal effect of the variable on the responsiveness to Allais paradox.

Another important factor which contributes to the decision making under uncertainty is the framing of the situation. Nowadays, it is usual that the individual has certain obligations to carry. For instance, elderly parents who have to be supported, children, or simply a student loan which has to be repaid. Therefore, the decision maker has to change his/her preference including the factors that he/she has to account for while making the decision. These factors represent the self-imposed constraints which may decrease the expected utility of the decision maker or change the intuition of the choice, and, thus illustrate the violation of Expected Utility Theorem (Kant, 1788). Frisch (1971) illustrates the problem of self-imposed constraints with the situation where a husband has to choose between 2 cakes a piece of cake for himself and a piece for his wife. Both cakes look delicious and it is hard to choose. The problem that the husband faces is how to maximize the joint utility, so that both people are satisfied, as well as how to maximize his own utility and the utility of his wife separately. The decision maker faces the same problem in terms of investments. The fiduciary has to find the optimal investment strategy which would satisfy trustee him/herself, as well as, people who they are making the decision for, while, additionally, satisfy both parties simultaneously. Therefore, I find significant academic evidence of the effect of self-imposed constraints on the decision making under uncertainty. The paper aims to examine overall responsiveness of students with/without financial obligations to Allais paradox as well as analyze the situations when respondents are more likely to violate the independence axiom (gain or loss lottery).

Considerably less academics discuss the importance of experience on the decision making as well as discuss the rationality of the decisions under the emotion of regret (Hoerl, 2007). The experience can influence the choice of decision maker based on the emotion that it creates. The investor who has made an investment and experienced positive return more probably will repeat the investment in the same manner, because the investment brought him/her positive experience and utility gain. On the contrary, if the investor has experienced a loss connected to the investment, most probably he/she will not be engaged in the similar investment again, or, if it happens, the investment behavior will differ. Thus, our investment strategy and the choice in decision making is highly dependent on the emotions that we have experienced the last time we have performed certain actions. However, if under positive experience the conclusion is quite self-explanatory, the effect of negative experience is not that clear. Numerous papers have examined the effect of negative experience (or experience of regret) on the decision making. The papers suggest ambiguous results. Some papers have concluded that experience of regret brings positive value to the rational decision making. The logics behind the claim is that bad

experience can help avoid mistakes and analyze the event more thoroughly next time (Zeelenberg & Pieters, 2004; Ratner & Herbst, 2005; Roese & Summerville, 2005; Pieters & Zeelenberg, 2007; O'Connor, McCormack & Feeney, 2014). On the other hand, numerous papers present evidence of negative relationship between rationality and negative experience (Morewedge, Gilbert, & Wilson, 2005; Schacter, Benoit, De Brigard, & Szpunar, 2015). Authors explain that experiencing regret from the taken decision can influence the perception of the situation and lead to a loss of the ability to analyze the lottery rationally. The reason can be found in the episodic memory, which recreates the feelings associated with the previous negative experience (Zimmermann, 2014). Therefore, the decision maker tends to remember his/her own atypical experience instead of how it supposed to be. Number of studies also suggest that negative experience decreases the willingness of decision maker to be engaged in a lottery which assumes risky behavior (Ritov, 1996). In this paper, the investigation on whether the negative experience and episodic memories of regret can have a significant effect on the rationality of decision making is performed. The individuals who have general business education background are examined.

Less controversial is the opinion on education and financial literacy effect on rational behavior. Financial literacy, in its basics, focuses on the ability of an individual to manage personal finance, making appropriate decisions in various financial areas (Investopedia, 2017). Huck and Muller (2012) in their paper illustrate the positive relationship between rationality and education. The paper suggests that tendency for violations of Rational Choice axioms drops with education level. This is correlated with the ability of more educated individuals to understand the mechanisms of financial market and, thus, make more rational decisions (Moore, 2003; van Rooij, Lusardi & Alessie, 2007; Borghans, Duckworth, Heckman & Weel, 2008; Stango & Zinman, 2008; Lusardi & Tufano, 2009). Highly discussed in academics is improved ability of an individual with financial education background in managing, accumulating and planning finance, and improvements in ability to recognize and analyse financial benefits which serve the solid base for rational decision making and more successful investment strategies (Ameriks et al., 2003; Hilgert, Hogarth & Beverly, 2003; Lusardi, 2005; Stango & Zinman, 2008; Carpena & Zia, 2011; van Rooij et al., 2012). Numerous papers link the participation in stock market and diversification of the portfolio with financial literacy of the investor (Graham et al., 2009; Guiso & Jappelli, 2009; Christelis, Jappelli & Padula, 2010; Almenberg & Widmark, 2011; Van Rooij, Lusardi & Alessie, 2011; Yoong, 2011; Almenberg & Dreber, 2015). Moreover, it is assumed that information gathering cost about the market and

its risks are significantly lower for more educated individuals (Hastings, Mitchell & Chyn, 2011). Therefore, there is strong academic evidence in favor of literacy and financial literacy effect on decision making. Nevertheless, the purpose of the paper is to examine whether there is a significant effect of the education program with major profile in Finance on decision making or the effect of education sums up to overall improvement in cognitive ability. The paper by van Rooij, Lusardi and Alessie (2007) suggests that the level of financial awareness and financial literacy is significantly dependent on the education acquired by an individual. Murphy (2005) claims that education from Business Administration and Economics facilitates more rational behavior in decision making under uncertainty compared with other study fields. However, Cole & Shastry (2009) note that education in Finance improves ability of rational decision making the most. That can be explained by the opportunity to learn about financial market, as well as the ability to acquire the core knowledge about finance that can be scarce for individuals who are enrolled in other programs. In this paper, the effect of different major profiles within Master's program in Economics and Business Administration is examined. Due to the reason that all respondents have business education background, the difference between the different majors is expected to be insignificant, however, I strongly believe that the responsiveness to the Allais paradox decreases with the discrete increase in number of respondents within major profile in Finance. The effect of the major profile is measured in terms of extra opportunity to be enrolled in more courses in financial sphere and, thus, it improves the financial awareness and cognitive ability in financial sphere discussed before. In other words, the aim of the paper is to examine whether the Finance students are less responsive to the Allais paradox compared to respondents from other major profiles offered in NHH.

4. Hypotheses

Based on the theories discussed before and on empirical research presented, the following hypotheses are formulated and are examined in the paper:

Hypothesis 1:

Gender has significant effect on decision making: men are less likely to be responsive to the Allais paradox and tend to violate independence axiom less often.

Hypothesis 2:

Age has positive influence on rationality of the decision making, and thus, lower responsiveness to Allais paradox is presented by older individuals.

Hypothesis 3:

Additional financial literacy acquired from the major profile in Finance affects the understanding of financial mechanisms which facilitate more rational thinking in decision making under uncertainty compared with other five major profiles given at NHH - Norwegian School of Economics, and, thus, the lowest responsiveness rate to Allais paradox is given by students within the major in Finance.

Hypothesis 4:

Negative experience with financial loss contributes to improvement in the analytical ability of the respondent and, thus, leads to more rational thinking. As a result, the response to the Allais paradox is less often presented by the individual who has had the negative experience.

Hypothesis 5:

Financial obligations connected with self-imposed constraints in terms of children, student loan or elderly parents contribute to the more rational decision making under uncertainty, reduce the quantity of violations of the independence axiom and, thus, present lower responsiveness to Allais paradox from an individual with financial obligations.

5. Method

In this part the tools for the empirical study are discussed. The data, regression model and the variables used in the empirical examination of the relationship between explanatory variables and the responsiveness of Master's students to the Allais paradox are presented. Furthermore, the diagnostic tests are performed in order to eliminate the possibility of misleading results.

5.1 Data

For this research cross section data is used, which gives an opportunity to investigate the effect of several variables on the dependent variable in one specific point of time (Gujarati, 2004). The paper presents the data over 243 individuals (115 men and 128 women) in age group 21-38, who are the Master's students at NHH - Norwegian School of Economics with different major profiles in their studies. The aim of the research is to discover what characteristics (age, gender, major in studies, experience or financial obligations) does the individual with business education background who is more likely to respond to Allais paradox have.

There is only one Bachelor's program in NHH. It is not included in the study due to the fact that it is impossible to find any effect of the education profile. On the other side, NHH has six specializations within Master's program: Economics, Finance, Energy Natural Resources and the Environment, International Business, Strategy and Management and Marketing and Brand Management. That is the reason why only Master's students are eligible for the study. Moreover, the selection is made in order to be able to assume that all respondents have acquired basic courses in business and economics area which provide all respondents with approximately the same general level of business literacy. Therefore, the only factor which could contribute to more advanced literacy is the knowledge obtained due to the major program within Master's program.

Respondents were reached via email or with the help of internet networks with the invitation to participate in the research and attached link to the questionnaire. Students could access questionnaire when they had time and in the most relaxing environment. This facilitated them to think carefully before answering the questions and as a results led to more accurate data. No reward was offered to a respondent. That, from one side, contributed to a small number of the people who filled in the questionnaire. However, from the other side, it gave an opportunity to examine only the people who are willing to contribute to the research. Moreover, it eliminated the possibility of the error linked with the students, who participated in the questionnaire only

in order to be eligible for the price lottery. The summary information over useful variables obtained due to the questionnaire is described in Table 1.

Table 1 “Summary information over the data obtained from the questionnaire”.

Variables	Mean	Std. Deviation	Min	Max
Gender	0.5267	0.50003	0	1
Age	25.8519	2.6958	21	38
Major	-	-	-	-
Experience	0.4239	0.4952	0	1
Obligations	0.5185	0.50069	0	1
Allais _{gain}	0.3786	0.4860	0	1
Allais _{loss}	0.2922	0.4557	0	1
FIE	0.1564	0.3640	0	1
MBM	0.2058	0.4051	0	1
STR	0.1770	0.3824	0	1
INB	0.1605	0.3678	0	1
ENE	0.1605	0.3678	0	1
ECN	0.1399	0.3476	0	1

Note: the variable Major does not show any information since it is a string variable in the data set and represent major in studies for a student within Master’s Program.

The questionnaire was constructed as following. The overall information was provided, informing the respondent about the goal of the research as well as ensuring about full anonymity. The questions which were offered to a respondent grouped the answers depending on respondents’ age and gender, whether or not they have had a negative experience with financial loss and any financial obligations, for instance children, student loan, elderly parents etc. After that the respondent was offered to answer to lottery questions, which gave an opportunity to observe the intuition behind the respondent’s actions in the potential gain and potential loss lotteries. The sample of the questionnaire is illustrated in Appendix 1.

Most of the variables represent binary values, meaning they take value 1 if the respondent falls into a category and 0 if not. Variables Allais_{gain} and Allais_{loss} take value 1 if the respondent has violated independence axiom in the corresponding lottery, and thus, respond to Allais paradox.

The questionnaire consists only of 9 questions in order to keep the focus throughout the whole examination. Despite the short survey, it provides all valuable information for further investigation.

5.2 Method selection

In this section different estimation methods are discussed and tests performed in order to find the most suitable regression models for the research.

Ordinary Least Squares is one of the most common estimation methods used for examining causal relationship between the variables. The goal of the OLS is to minimize the sum of squared differences between the observed values given in data and the predicted values given by linear function (Gujarati, 2004). The model for predicting the probabilities proposed by OLS estimation method is Linear Probability Model. The LPM is the approach for predicting probabilities of the event given the certain categorical classification of the observation. The model and estimation method is widely used because of the simplicity in the interpretation of the coefficients. However, it has some drawbacks which I would like to avoid in this paper. Firstly, the LPM allows probabilities to be outside the interval of 0 and 1, and, secondly, the LPM faces the heteroscedasticity problem. That is the reason why in the empirical study the Maximum Likelihood Estimation method is used. Myung (2003) explains the Maximum Likelihood Estimate as the value of the parameter that makes the binary dependent variable to take value of 1 most likely. Moreover, the MLE has many properties which make the use of it more valuable for the research than the method of OLS. For example, the complete information about the parameters of interest and lowest possible variance of the parameters (Myung, 2003). Therefore, Maximum Likelihood Estimation method is selected to be more suitable than OLS for the research.

One of the regression models which uses MLE method for estimating the regression estimates is logit model. It is not as widely used as simple linear regression, however, it can create a great value for the research which aims to examine the effect of the explanatory variables on the dichotomous dependent variable. For example, logit regression model can explain how does the probability of giving a vote (yes or no) change for every additional respondent who has voted before. Therefore, it is a useful model for illustrating the effect of discrete, nominal and continuous variables on a binary dependent variable. Table 2 illustrates the predicted probabilities interval of 3 regression models, as well as, the minimum probability outside the interval 0 and 1 for LPM.

Table 2 “The minimum and maximum predicted probabilities in logit, probit and linear probability models.

Model	Lottery with potential gain outcome		Lottery with potential loss outcome	
	Min	Max	Min	Max
Logit	0.0557	0.8400	0.0113	0.8734
Probit	0.0475	0.8374	0.0045	0.8671
LPM	-0.0351	0.8307	-0.1646	0.8001

Logit and probit are regression models which use the Maximum Likelihood Estimation method and provide good analysis for regression with binary dependent variable. The difference between probit and logit models is the distribution function $F(\cdot)$. The logit model uses the cumulative distribution function of the logistic distribution $F(\cdot) = \Lambda(\cdot)$, whereas probit model specifies $F(\cdot)$ with the use of standard normal cumulative distribution function ($F(\cdot) = \Phi(\cdot)$) (Cameron & Trivedi, 2009). The table in Appendix 4 summarizes the difference between three regression models. Moreover, Amemiya (1981) proposed the conversion factor for estimated coefficients of three mentioned regression models. That makes it possible to calculate approximate estimate using any of three regression models.

Table 3 “Conversion factor between the coefficients of Logit, Probit and Linear Probability models”.

$$\hat{\beta}_{logit} \approx 4\hat{\beta}_{LPM}$$

$$\hat{\beta}_{probit} \approx 2.5\hat{\beta}_{LPM}$$

$$\hat{\beta}_{logit} \approx 1.6\hat{\beta}_{probit}$$

In this research, due to the reason that the assumptions for the use of the logistic regression model (Appendix 3) are met and the difference between probit and logit model is not significant, for the examination of statistical significance of explanatory variables on the responsiveness to Allais paradox the logit regression model is selected.

5.3 Variables selection

In order to present reliable analysis, the variables which will bring value for the model have to be selected.

One of the assumptions which has been inherited from OLS models assumes that each observation is independent and the variables are not correlated. The matrix presented in Table 4 shows correlation between explanatory and dependent variables.

Table 4 “Correlation matrix between explanatory and dependent variables”.

	Allais~n	Allais~s	Age	Experi~e	Obliga~s	FIE	MBM	STR	INB	ENE	ECN
Allaisgain	1.0000										
Allaisloss	0.2074	1.0000									
Age	-0.1999	-0.2102	1.0000								
Experience	-0.2746	-0.2947	0.2918	1.0000							
Obligations	-0.1478	-0.3226	0.2531	0.1432	1.0000						
FIE	-0.0791	-0.1271	-0.0732	0.0434	-0.0613	1.0000					
MBM	0.1274	0.1207	-0.0476	-0.1070	0.0015	-0.2191	1.0000				
STR	0.0160	0.1052	0.0376	-0.0486	0.0583	-0.1996	-0.2360	1.0000			
INB	-0.1333	-0.2070	0.1449	0.0560	0.0623	-0.1882	-0.2225	-0.2027	1.0000		
ENE	0.1903	0.2368	-0.0801	-0.0574	-0.1172	-0.1882	-0.2225	-0.2027	-0.1912	1.0000	
ECN	-0.1436	-0.1548	0.0222	0.1342	0.0563	-0.1737	-0.2053	-0.1870	-0.1764	-0.1764	1.0000

Evans (1996) and Beldjazia & Alatou (2016) suggest that the values in correlation matrix below 0.4 have to be considered as very weak or weak correlation, whereas the correlation above 0.80 suggests very strong correlation between the variables. The problem of very strong correlation can lead to misleading results, therefore, the value over 0.8 would indicate the variables which have to be excluded from the model. After examining the correlation matrix, one can see that the strongest correlation between explanatory variables presented in Table 4 is the positive correlation between variables Age and Experience. The logical explanation is that the cognitive ability increases with age. The strongest correlation to responsiveness to Allais paradox is presented by variables Experience, for the lottery with potential gain outcome, and Obligations, for the lottery with potential loss outcome. That means that an individual who has experienced big financial loss or the utility loss associated with unsuccessful investment is less responsive to Allais paradox in the lottery with the potential gain outcome. Financial obligations have the greatest negative impact on the responsiveness to Allais paradox in the lottery with potential loss outcome. The matrix suggests that people who have financial obligations are less likely to be responsive to the Allais paradox in the lottery with potential loss outcome. Furthermore, the correlation matrix does not find any evidence of very strong correlation between the explanatory variables. Therefore, the mentioned variables can be used for the examination of

the effect on the responsiveness to Allais paradox in the lotteries with potential gain and potential loss outcomes.

The multicollinearity test is performed in order to investigate whether there are several variables which are correlated simultaneously. The analysis of the test performed on “the rule of thumb”, which suggests that the VIF which exceeds value 5 indicates the multicollinearity problem. Table 5 presents the results obtained in collinearity diagnostics test.

Table 5 “Results from Collinearity Diagnostics test”.

Variable	VIF	SQRT VIF	Tolerance	R-Squared
Gender	1.13	1.06	0.8847	0.1153
Age	1.18	1.09	0.848847	0.1528
Experience	1.21	1.10	0.8232	0.1768
Obligations	1.10	1.05	0.9108	0.0892
FIE	1.53	1.23	0.6557	0.3443
STR	1.56	1.25	0.6400	0.3600
INB	1.53	1.24	0.6519	0.3481
ENE	1.53	1.24	0.6436	0.3464
ECN	1.51	1.23	0.6632	0.3368
Mean VIF	1.36			

Note: Since collinearity diagnostics is performed after the regression model, the MBM, which is default group for the model is not included in the collinearity diagnostics table.

The Table 5 suggests no multicollinearity between the variables since the VIF value for each variable follows “the rule of thumb” and is quite low. The mean VIF value is 1.36 which falls in the rule of thumb and does not imply multicollinearity, therefore, the results suggest that selected variables have no multicollinearity problem and can be included in the regression model. Table 6 summarizes the information about the variables included in the analysis.

Table 6 “The description of the variables used in the regression models”.

Variable	Description	Unit
Gender	Gender of the respondent.	Binary variable, which takes value 1 if the respondent is a woman and 0 if a man.
Age	Age of the respondent	Years
Obligations	Shows whether the respondent has self-imposed constraints in terms of financial obligations which have to be taken into consideration (e.g. elderly parents, children, student loan etc.)	Binary variable, which takes value 1 if the respondent has financial obligations and 0 if not.
Experience	Indicates whether the respondent has had a negative experience which led to big financial loss.	Binary variable which takes value 1 if the respondent has had the negative experience and 0 if not.
MBM	Major in Marketing and Brand Management	Binary variable which takes value 1 if the respondent takes the major profile in “i” within the program and 0 if no.
STR	Major Strategy and Management	
INB	Major in International Business	
ECN	Major in Economics	
ENE	Major in Energy, Natural Resources and the Environment	
FIE	Major in Finance	

5.4 Specification of the model

The core model for developing the effect of gender and age on the decision making was proposed by Sanz de Acedo Lizarraga, Sanz de Acedo Baquedano & Cardelle-Elawar (2007).

$$\text{Decision making factor} = \alpha + \beta_1 \text{Age} + \beta_2 \text{Gender} + \varepsilon_i \quad (6)$$

Authors propose that the variables Age and Gender affect task and subject factors for the decision making and as a result could influence the intuition of the choice. In this paper, the effect of age and gender on responsiveness to the Allais paradox is examined in two lotteries. Therefore, the core model for the research can be expressed as following:

$$\text{Allais}_i = \alpha + \beta_1 \text{Age} + \beta_2 \text{Gender} + \varepsilon_i \quad (7)$$

where the dependent variable Allais_i takes value of 1 if there is a violation of independence axiom, meaning the positive response to the Allais paradox. α and β_i are constant term and the estimated coefficients proposed by the regression output, Age is a continuous variable measured in years, Gender is dichotomous variable which takes value of 1 if the respondent is a woman and 0 if respondent is a man and ε_i is an error term which captures the effect of variables that are not specified in the model. Model proposed in Equation 7 is referred as Basic model in further analysis.

Furthermore, in this research, the basic model is expanded by introducing dummy variables which indicate whether the respondent falls into the category, and variable takes value 1, or no, and the variable takes the value of 0. Thus, the models can be described as:

$$\text{Allais}_{\text{gain}} = \alpha + \beta_1 \text{Age} + \beta_2 \text{Agesq} + \beta_3 \text{Gender} + \beta_4 \text{Experience} + \beta_5 \text{Obligations} + \beta_6 \text{FIE} + \beta_7 \text{INB} + \beta_8 \text{ENE} + \beta_9 \text{STR} + \beta_{10} \text{ECN} + \varepsilon \quad (8)$$

$$\text{Allais}_{\text{loss}} = \alpha + \beta_1 \text{Age} + \beta_2 \text{Agesq} + \beta_3 \text{Gender} + \beta_4 \text{Experience} + \beta_5 \text{Obligations} + \beta_6 \text{FIE} + \beta_7 \text{INB} + \beta_8 \text{ENE} + \beta_9 \text{STR} + \beta_{10} \text{ECN} + \varepsilon \quad (9)$$

Note: variable MBM is not included in the equation (8) and equation (9), since it is a default category for the variable which indicates the major profile in studies.

The models are presented for each lottery situation. The expanded model shows the effect of age and gender on the responsiveness to Allais paradox, as well as, captures the effect on the decision making which can be explained by whether the respondent have had negative experience which led to financial loss, whether the respondent has certain financial obligations

(children, student loan), which could facilitate or create a negative effect on responsiveness to the Allais paradox, and how the major in studies can affect the rationality of the decision maker. It is important to note that in the expanded version of the model the variable Agesq is included. The reason for that is the attempt to adjust for non-linear relationship between Age and the dependent variable. Moreover, since variables Age and Agesq have the correlation explained by the same nature of the variable, both variables are demeaned.

5.5 Model diagnostics

In this part the diagnostics for presented models is performed. In order to have the prove that the models which are used for further investigation of the effect on the responsiveness to Allais paradox are reliable, three test are performed.

First of all, proposed expanded regression models have been tested for the goodness of fit. Hosmer-Lemeshow test compares the fitted probabilities within subgroups with the sample frequency of the dependent variable (Gujarati, 2004). The null hypothesis for the test states that there is no lack of fit in the model, meaning that the sample frequency and the fitted probabilities are equal. The results of the test performed for 2 lotteries are reported in Table 7.

Table 7 “Hosmer-Lemeshow goodness of fit test results”.

	Lottery with potential gain outcome	Lottery with potential loss outcome
Hosmer-Lemeshow Chi2(8)	5.46	9.38

Note: * Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level; Number of observations 243; Number of groups 10.

The test over 243 observations has been performed. The observations have been grouped in 10 groups which is the usual quantity of groups. The Hosmer-Lemeshow statistics with 8 degrees of freedom and Chi2 distribution shows that the test for the lotteries with potential gain and potential loss outcomes is not significant. Therefore, the results suggest that the null hypothesis cannot be rejected at 10% significance level and, thus, the models proposed for the study have no lack of fit.

Another way to test for goodness of fit in the regression model is to evaluate its classification diagnostics. The classification test compares the predicted outcomes in the model with the actual outcomes (Gujarati, 2004). Sensitivity shows the percentage of correctly classified observations, when Y takes the value of 1. Specificity measure indicates the percentage of

correctly classified observations, when Y is 0. Table 8 demonstrates the output of the classification test.

Table 8 “Classification diagnostics for the lotteries with potential gain and potential loss outcomes”.

Model		Lottery with potential gain outcome	Lottery with potential loss outcome
Sensitivity	$Pr(- D)$	54.35%	52.11%
Specificity	$Pr(- \sim D)$	82.12%	93.60%
Positive predictive value	$Pr(D +)$	64.94%	77.08%
Negative predictive value	$Pr(\sim D -)$	74.70%	82.56%
False + rate for true $\sim D$	$Pr(+ \sim D)$	17.88%	6.40%
False - rate for true D	$Pr(- D)$	45.65%	47.89%
False + rate for classified +	$Pr(\sim D +)$	35.06%	22.92%
False - for classified -	$Pr(D -)$	25.30%	17.44%
Correctly classified		71.60%	81.48%

The results show that in the lottery with potential gain outcome there are 71.60% correctly classified observations within the regression model, with 82.12% correctly classified when Y takes value 0 and 54.35% correctly classified when Y takes value 1. In the lottery with potential loss outcome, the diagnostics suggests 81.48% correctly classified observations within the regression model, with 93.60% correctly classified when Y=0 and 52.11% correctly classified observations when Y takes value 1. The classification diagnostics shows that the regression models proposed for the analysis have good classification level, therefore are reliable for further analysis.

Link test gives the opportunity to evaluate whether all explanatory variables are correctly specified. The null hypothesis for the test states that there is no misspecification in the regression model. Table 9 shows the estimated coefficients for two lotteries examined in this paper. The test states that the $\hat{\beta}$ coefficient has to be significant unless the model is

absolutely incorrectly specified. From the other side, the significant coefficient for $_hatsq$ would indicate that the model suffers from misspecification or has a problem with omitted variable. The coefficients which have been estimated for the squared predicted values within the model are statistically insignificant for both situations. Therefore, the null hypothesis of no misspecification in the model cannot be rejected at 10% significance level, indicating that the proposed models do not suffer from misspecification of the variables and are reliable for the analysis.

Table 9 “Link test estimated coefficients for the lotteries with potential gain and potential loss outcomes”.

Coefficients	Lottery with potential gain outcome	Lottery with potential loss outcome
$_hat$	0.982015*** (0.2255935)	1.022082*** (0.1949191)
$_hatsq$	-0.0158574 (0.1403937)	0.0141219 (0.0828836)
$_cons$	0.008861 (0.1767234)	-0.0115857 (0.2013234)

Note: * Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level; the standard errors are reported in the brackets.

The model diagnostics given in this part of the paper suggests no lack of fit confirmed by Hosmer-Lemeshow goodness of fit test, as well as, the classification diagnostics given for the lotteries. The lowest correctly classified rate has been obtained by the lottery with potential gain outcome (71.60%) and the highest percentage of correctly classified observations has been given by the lottery with potential loss outcome (81.48%). Moreover, the misspecification test suggests that the models do not suffer from misspecification of the variables. That is the reason why, I strongly believe that the regression models and the variables proposed for the research have all necessary qualities for the comprehensive analysis.

6. Empirical findings

This section presents descriptive statistics and illustrates the regression results for the basic model (which includes only two explanatory variables), and for the expanded version of the model (which includes variables of interest for the research). The effect of the variables on the responsiveness to Allais paradox is examined in the lottery with potential gain outcome and in the lottery with potential loss outcome. The key findings are discussed regarding each situation separately and the summary for both lotteries is presented.

6.1 Lottery with potential gain outcome

The lottery with potential gain outcome gives the opportunity to evaluate how the respondent behaves when he/she is offered to make the choice knowing that the final outcome will be positive regardless the alternative chosen.

6.1.1 Description of the lottery

First, the respondents were asked to select one of the following alternatives:

Alternative A: 100% chance of winning NOK 1000.

Alternative B: 10% chance of winning NOK 5000, 89% chance of getting NOK 1000 and 1% of getting nothing.

Then, the same group of students was asked to select one of the alternatives:

Alternative A': 11% chance of winning NOK 1000, 89% winning nothing.

Alternative B': 10% chance of winning NOK 5000, 90% winning nothing.

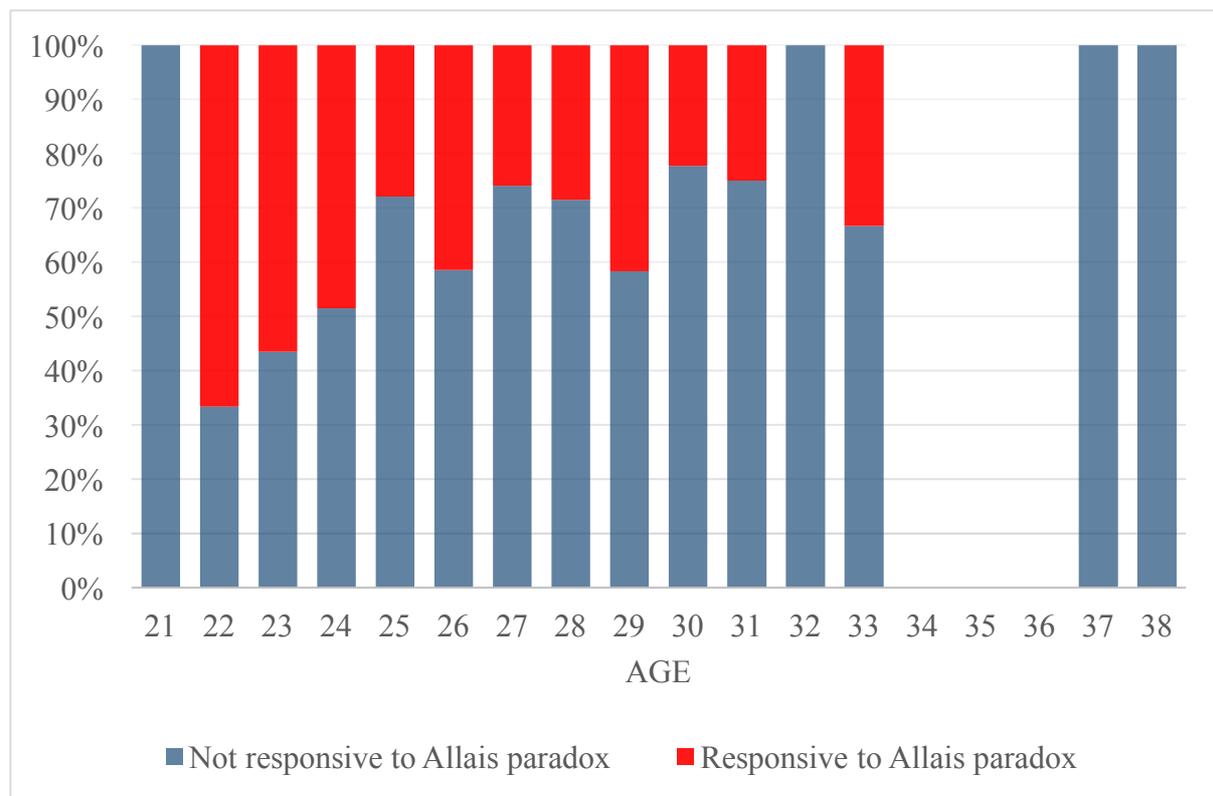
The alternatives in the first lottery (alternative A and alternative B) have the common sequence, which is the 89% probability of getting NOK 1000. In the second pair of alternatives this common sequence is removed. The common sequence, according to the independence axiom, has to be ignored when making the choice, since the choice has to be made only based on the differentiating part of the alternative. That is the reason why if the respondent preferred alternative A in the first lottery, the alternative A' has to be also preferred to alternative B' in the second lottery. The combination of answers AB' or BA' is counted as violation of independence axiom, and the response to the Allais paradox.

6.1.2 Descriptive statistics

The lottery with potential gain outcome has been violated by 92 respondents (37.9%). Moreover, the statistics shows that 24.3% of men and 50% of women have provided answers which violate the independence axiom. In the lottery with potential gain outcome, both men and women are more likely to select the risky alternative. The descriptive statistics suggests that both groups of students, men and women, tend to choose risky alternative in the lottery with potential gain outcome. Only 33.75% of women and 15% of men respondents have selected the safe option to be more attractive in the first pair of alternatives. However, when the common sequence was removed from the alternatives 22.58% of women and 13.13% of men have selected the safe option. The findings confirm that in a situation when the probability of winning is low, most of the respondents choose riskier option.

The responsiveness to the Allais paradox within each age category is illustrated by Figure 1. In the figure the rate of responsiveness to Allais paradox is highlighted in red and the percentage of answers which do not respond to Allais paradox is displayed in blue color.

Figure 1 “Responsiveness to Allais paradox based on the age of the respondent”.

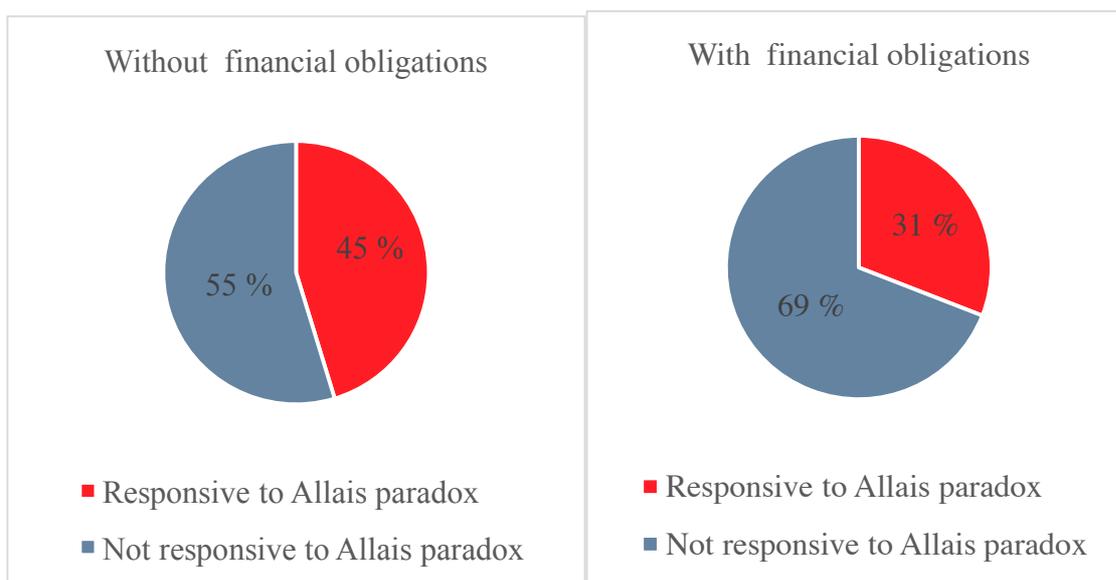


In the figure the inverted U-shape relationship between the responsiveness to the Allais paradox and age is not clearly observable, however, the presence of the positive trend indicating more

rational behavior can be observed in the age group 22-25. Moreover, it can be clearly seen that the greatest percentage of answers violating the independence axiom has been given by the students who are 22 years old. The reason for it may be the fact that there are a few respondents in this age group, meaning that the descriptive statistics cannot be absolutely reliable. Figure 1 also illustrates outliers in age 21, 37 and 38. That contradicts to the findings discussed in the empirical background part of the paper. The descriptive statistics suggests that the youngest and the oldest respondents in this sample are absolutely rational, meaning that there is no effect of age on the decision making. Nevertheless, all observations in the interval 22-33 illustrate the effect of age on the responsiveness to the Allais paradox. Therefore, the observations 21, 37 and 38 have no significant statistical power in descriptive statistics. However, the observations can bring the value for the results estimated by the regression model.

The descriptive statistics over the violations of the independence axiom in the group of students with and without financial obligations is illustrated in Figure 2. The graphs show the percentage of respondents who have violated the independence axiom in each group.

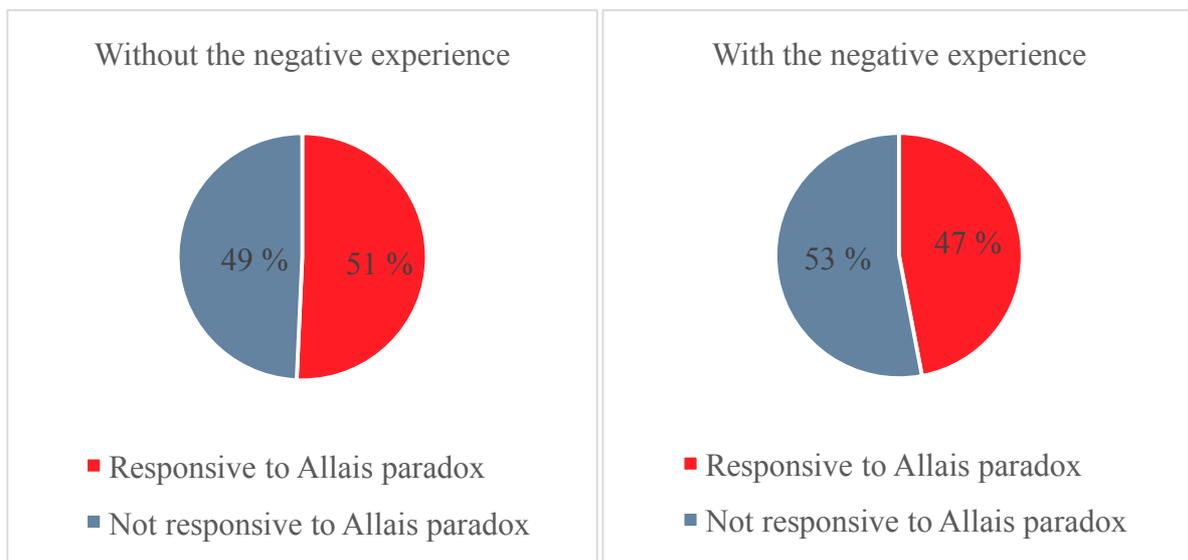
Figure 2 “Responsiveness to Allais paradox based on the presence of financial obligations”.



According to the results given in Figure 2, it is clear that the role of the variable is significant in this research, because the respondents who do not have any financial constraints have given 45% of the response to Allais paradox, whereas the students who have the financial obligations only 31%. Thus, that means that financial obligations in terms of elderly parents, children, student loan etc. have negative effect on the responsiveness to Allais paradox among Master’s students in NHH.

Figure 3 illustrates the effect of the negative experience on the responsiveness to Allais paradox. The descriptive statistics suggests that there is a negative effect of the negative experience on the responsiveness to Allais paradox. Figure 3 demonstrates that students who have experienced the financial loss associated with the lottery in which they have participated before have given lower percentage of the answer combinations which violate the independence axiom (47%). In the sample of students who did not have any negative experience with financial loss 51% of respondents can be considered as responsive to the Allais paradox.

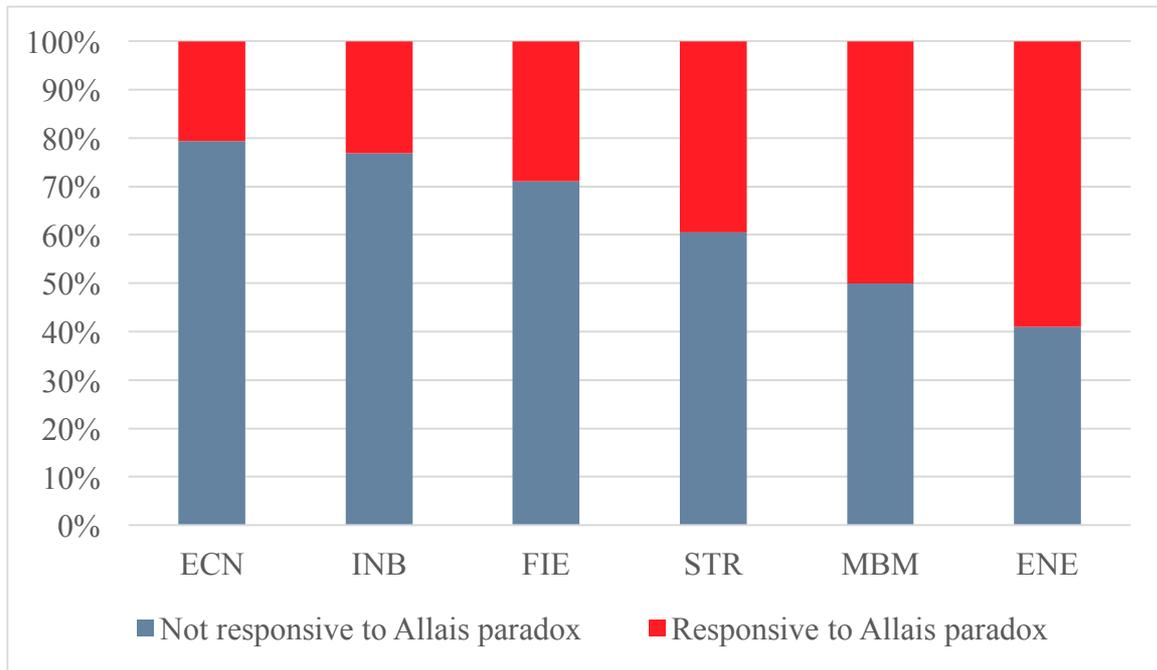
Figure 3 “Responsiveness to Allais paradox based on the presence of the negative experience”.



Thus, the negative experience, based on the descriptive statistics, has positive effect on people’s rationality in the financial lotteries. However, there is a minor difference between the groups, therefore, further investigation is needed in order to examine whether the significance of the variable can be statistically proven.

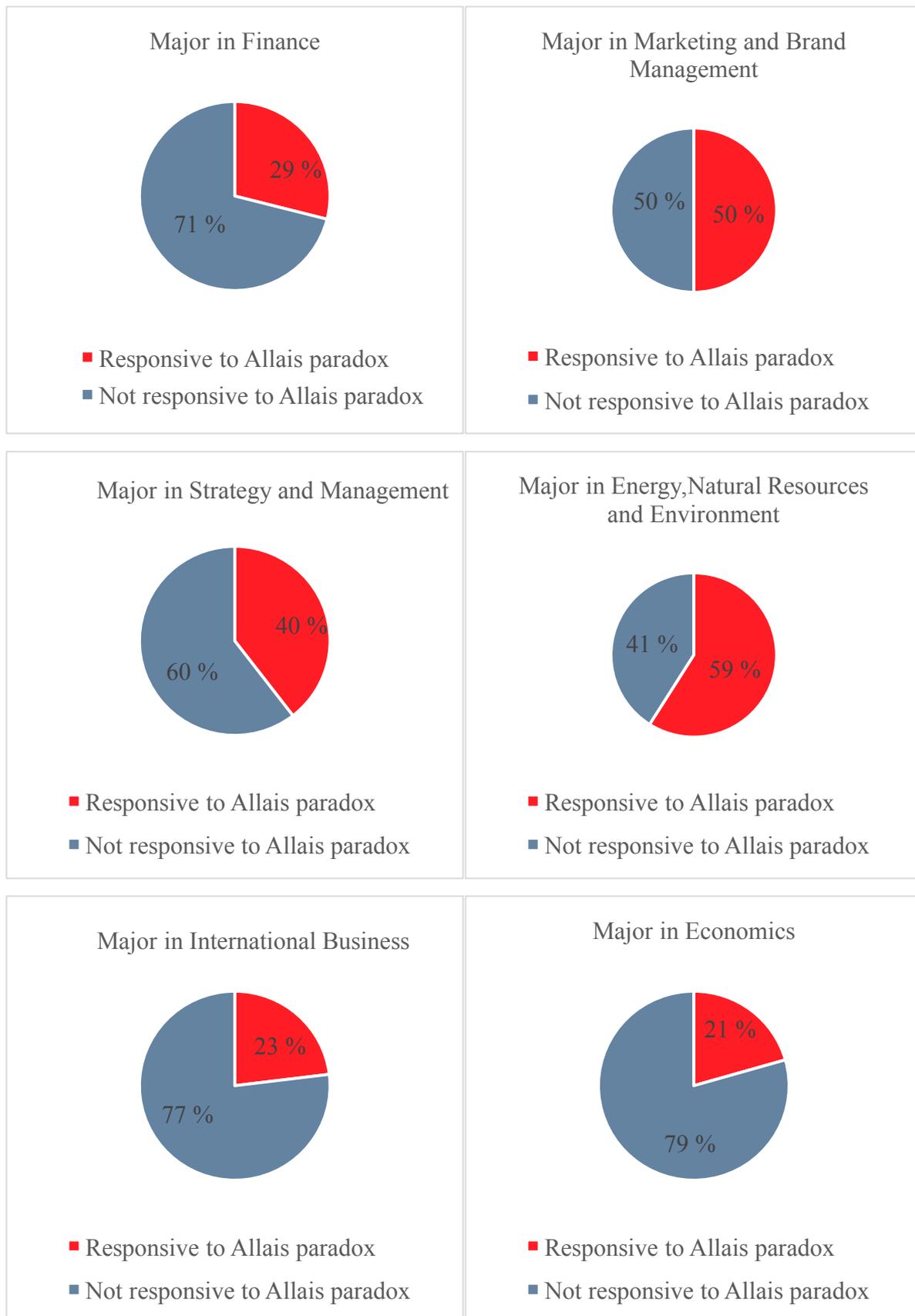
Figures 4 and 5 illustrate the percentage of violating answers given by each major profile in Master’s program offered at NHH. The figures show that the most irrational behavior in terms of violations of independence axiom is performed by the students within the major in Energy, Natural Resources and the Environment. 59% of the students within the profile have shown the response to Allais paradox. From the other hand, only 21% of students within major profile in Economics have violated the independence axiom in the lottery with potential gain outcome.

Figure 4 “Responsiveness to Allais paradox based on the major profile in studies in the lottery with potential gain outcome”.



Moreover, one can observe that the responses have divided the students into two groups. The first group can be shared by the students who gave greater percentage of irrational answers. In this group Energy, Natural Resources and the Environment (59% of violations), Marketing and Brand Management (50% of violations) and Strategy and Management (40% of violations) profiles can be pooled. The second group, on contrast, can be combined from the major profiles within Master’s program which have given lower rate of violations of the independence axiom. Therefore, the second group can be built from the major profiles in Economics (21% of violations), International Business (23% of violations) and Finance (29% of violations). One of the hypotheses formulated earlier states that the least responsive to Allais paradox students are taking Master’s program with the major profile in Finance. The descriptive statistics suggests, that the best performing group of students is enrolled in the major profile within Economics. They are the least likely to be responsive to Allais paradox.

Figure 5 “Responsiveness to Allais paradox within each major profile in the lottery with potential gain outcome”.



The purpose of descriptive statistics is to highlight the main trends in the responsiveness to Allais paradox within the sample of Master's students. However, the regression model analysis has to be performed in order to examine statistical significance of the findings.

6.1.3 Regression results

In order to find out how variables affect the decision making in the lottery with potential gain outcome, first, the basic regression, based on equation 7, is performed in order to find out whether there is an effect of Age and Gender variables on the responsiveness to Allais paradox. The results for the basic model are illustrated in the Table 10, the first column. The results show that both variables included in the analysis, Gender and Age, have significant effect on the decision making when no other variables are included into the regression model. Moreover, the regression output illustrates that women are more likely to violate the independence axiom, according to the data obtained with the questionnaire. Furthermore, the model predicts that older individuals are less likely to fall in the group of people who give the answer combinations which violate the independence axiom, meaning that older respondents, according to the data, are less likely to be in the group of responsive to the Allais paradox respondents. In general, the model with only two explanatory variables is statistically significant at 1% level.

In order to see the effect of added variables the expanded regression model illustrated by equation 8 is performed and the regression output is shown in Table 10 the second column. The expanded model is statistically significant and fits the data better than the basic model with only two explanatory variables. That is illustrated by the less negative values of Log likelihood. In the logit model the R^2 does not have any power, therefore, the Log likelihood predicts how well does the regression model fit the data. The constant term in the expanded model is statistically insignificant, meaning that if all variables take value 0 the individual has equal chances of being responsive and not responsive to the Allais paradox.

Table 10 “Estimated coefficients in basic and expanded models in the lottery with potential gain outcome.”

Variables	Lottery with potential gain outcome	
	Basic model	Expanded model
Gender	1.0880*** (0.2849)	1.0345*** (0.3198)
Age	-0.1632*** (0.0590)	-0.6735 (0.7749)
Agesq		0.0108 (0.0145)
Experience		-0.7564** (0.3297)
Obligations		-0.4447 (0.3087)
FIE		-0.8070* (0.4991)
INB		-0.9705** (0.5060)
ENE		0.5780 (0.4688)
STR		-0.1118 (0.4557)
ECN		-0.9614* (0.5491)
cons	3.0786 (1.5209)	9.8316 (10.2989)
Log likelihood	-148.3589	-135.5815
LR chi2	25.68***	51.24***
Pseudo R2	0.0797	0.1589
Number of observations	243	243

Note: * Significant at 10% level; ** significant at 5% level; *** significant at 1% level; the standard errors are reported in the brackets.

There are 5 variables which are statistically significant in the expanded regression model. Variable Gender has positive statistically significant effect on the responsiveness of NHH Master's students to Allais paradox. It predicts that in the lottery with potential gain outcome, an individual who responds to Allais paradox is more likely to be a woman than a man. The variable is significant at 1% significance level. Furthermore, variables Experience, FIE, INB, ECN illustrate the negative effect on the responsiveness to Allais paradox, meaning that the independence axiom is less likely to be violated by the Master's students with the major profiles in International Business (INB), Finance (FIE) or Economics (ECN) and respondents who have had the negative experience. According to the regression results for the lottery with potential gain outcome, the variables Age, Obligations, STR, ENE and Agesq are statistically insignificant and, therefore, the interpretation of their effect on the decision making can be misleading.

However, the aim of the study is to see the marginal effect of the explanatory variables on the responsiveness to Allais paradox. Table 11 presents marginal effect of the variables on the responsiveness to Allais paradox in the lottery with potential gain outcome. The basic model suggests that women are by 23.02% more likely to violate the independence axiom than man in financial lottery with potential gain outcome. The variable Gender also shows the greatest statistically significant effect on the rationality of the decision making in the expanded regression model. The variable predicts that a discrete change in the Gender leads to 19.58% higher probability of response to the Allais paradox from a female respondent. The results also show that an increase of 1 year in age of the respondent reduces the probability of the responsiveness to Allais paradox by 3.45% in the model with only 2 explanatory variables. On contrast, the expanded regression model shows no significant effect of the Age on the decision making of NHH students. Furthermore, the negative experience shows statistically significant effect on the decision making. The chance of violation of independence axiom decreases by 14.32% from a respondent with negative experience. Moreover, significant effect on the rationality in the decision making is statistically proven from the major profiles in International Business, Economics and Finance. The results show that the responsiveness to Allais paradox is by 18.37%, 18.20% and 15.28% less likely from respondents within International Business, Economics and Finance, respectively, than from student with the major profile in Marketing and Brand Management.

Table 11 “Marginal effect of the explanatory variables on the responsiveness to Allais paradox in the lottery with potential gain outcome”.

Variables	Lottery with potential gain outcome	
	Basic model	Expanded model
Gender	0.2302*** (0.0533)	0.1958*** (0.0559)
Age	-0.0345*** (0.0118)	-0.1275 (0.1458)
Agesq		0.0020 (0.0027)
Experience		-0.1432** (0.0600)
Obligations		-0.0842 (0.0576)
FIE		-0.1528* (0.0926)
INB		-0.1837** (0.0932)
ENE		0.1094 (0.0877)
STR		-0.0212 (0.0862)
ECN		-0.1820* (0.1017)

Note: * Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level; the delta method standard errors reported in the brackets.

6.2 Lottery with potential loss outcome

The second lottery which has been proposed to respondents is the lottery with potential loss outcome. The lottery gives opportunity to evaluate the behavior of the respondents when the final outcome is negative regardless the alternative chosen.

6.2.1 Description of the lottery

Firstly, students were proposed to choose one of the following alternatives:

Alternative A: Sure loss of NOK 1000.

Alternative B: 80% chance of losing NOK 5000 and 20% chance of losing nothing.

After that, the same group of students was asked to make the choice in favor of one of the following alternatives:

Alternative A': 10% chance of losing NOK 1000 and 90% probability of losing nothing.

Alternative B': 8% chance of losing NOK 5000 and 92% probability of losing nothing.

The proposed lotteries have common ratio since after the alternatives given in the first lottery are divided by 10, the lottery shows absolutely the same alternatives as proposed in the second lottery. Therefore, the individual who does not respond to Allais paradox has to notice this common component and ignore it when making the decision. The choice combinations AB' and BA' are considered as violation of independence axiom and thus, response to the Allais paradox.

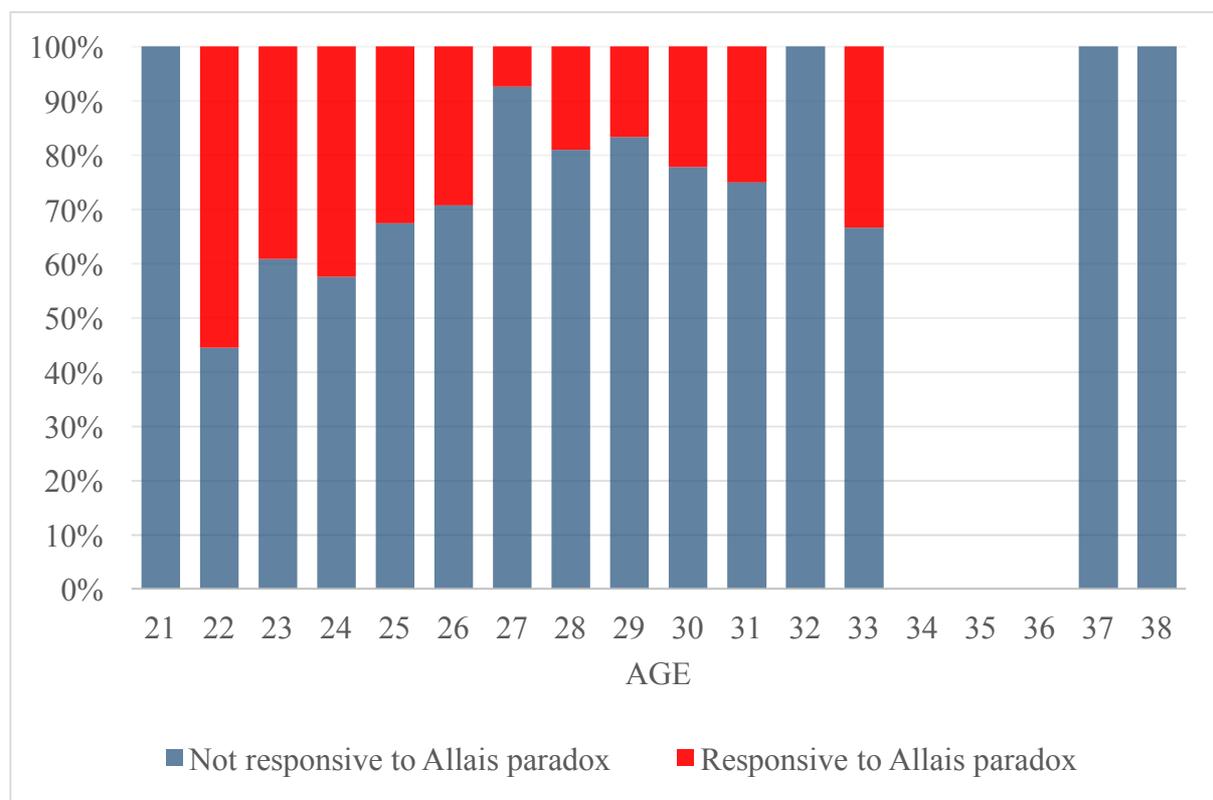
6.2.2 Descriptive statistics

In the lottery with potential loss outcome 71 (29%) people have violated the independence axiom. Moreover, 27.8% of men and 30.5% of women have provided the answer combinations which violate the independence axiom. The statistics shows that women still perform less rational behavior in the decision making in financial lotteries compared to men respondents. However, the difference between genders in their responses to the lottery with potential loss outcome is significantly smaller compared to the difference between genders in the lottery with potential gain outcome. Moreover, there is an increase in the percentage of answers which respond to the Allais paradox given by men and the drop in violating answers given by women. When selecting more attractive alternative from alternative A and B, 40% of women and 34.38% of men students have selected sure loss of NOK 1000. Moreover, when the common ratio is removed, only 30.63% of female respondents and 21.13% of male respondents found

the alternative A' more attractive. The findings show, that even facing the potential loss, NHH Master's students, both men and women, are more eager to select risky alternative. Moreover, both genders illustrate the tendency of overweighting small probabilities when the chances of winning are small.

The Figure 6 shows how the rate of responsiveness to Allais paradox is distributed according to Age category. The peak of violations is given by respondents who are 22 years old. However, this may be explained by a limited number of respondents in this age group, as discussed earlier. The respondents in age group 21,37,38 show the same statistics for both lotteries.

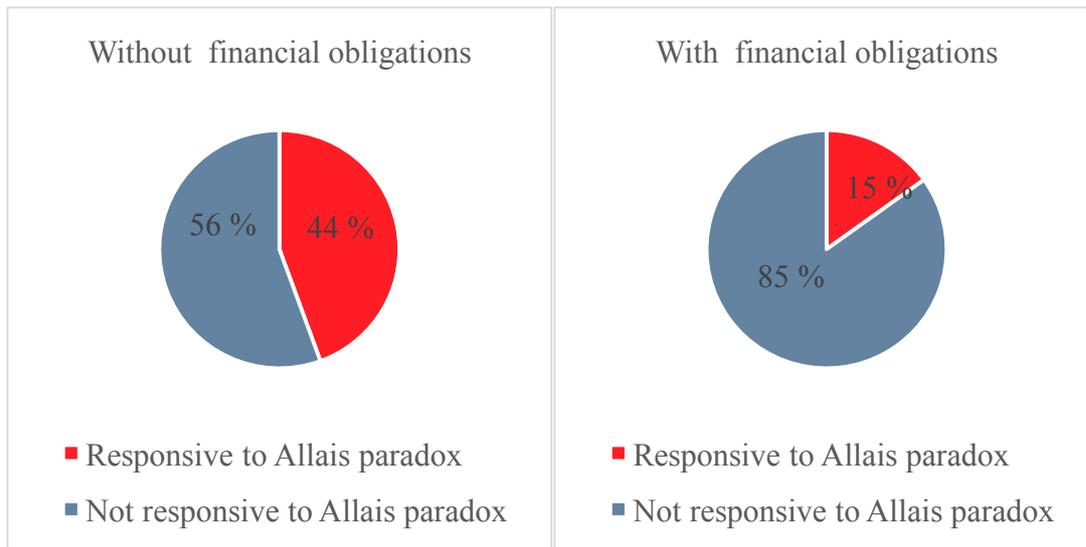
Figure 6 “Responsiveness to Allais paradox based on age”.



The most important pattern which is illustrated in Figure 6 is the inverted U-shape relationship which was noted by Tymula et al. (2013). If we apply the proposed relationship to the research topic, we can clearly see the inverted U-shape with some outliers in age 21, 32, 37 and 38. The descriptive statistics suggests that the peak for the rational decision making is in the age of 27, because the group of students in age 27 has provided with the smallest percentage of answers which violate the independence axiom. Therefore, age 27 can be viewed as turnover point for this relationship.

Figure 7 illustrates the percentage of violations given by respondents with and without financial obligations. The figure shows that in the lottery with potential loss outcome the presence of financial obligations has an effect on the decision making.

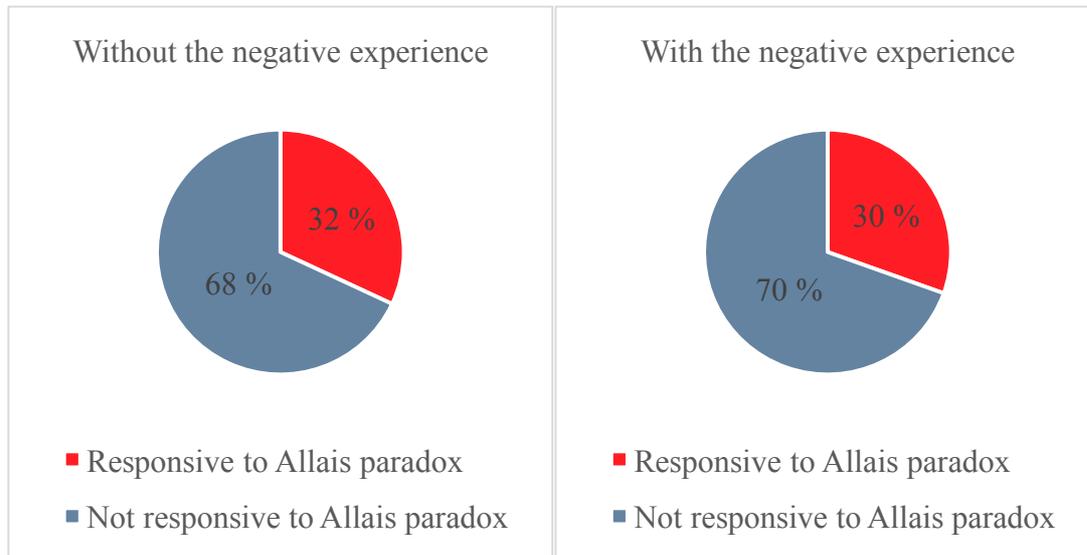
Figure 7 “Responsiveness to Allais Paradox depending on presence of financial obligations”.



Even though the change in the violations is not observable as the change from yes to no, the decrease in the percentage of responsiveness, from 44% to 15%, favors the claim that the financial obligations have positive effect on the rationality in the decision making. The higher percent in both groups (without financial obligations and with financial obligations) tend to select combination of the alternatives which does not violate the independence axiom.

The responsiveness to Allais paradox based on the presence of negative experience is illustrated in Figure 8. According to the results demonstrated by the Figure 8, more answers which violate the independence axiom are given by the respondents without negative experience, confirming the hypothesis which states that the negative experience has negative effect on the responsiveness to Allais paradox. However, the difference between the groups is insignificant, only 2%, therefore, in order to obtain reliable results, the statistical significance has to be examined.

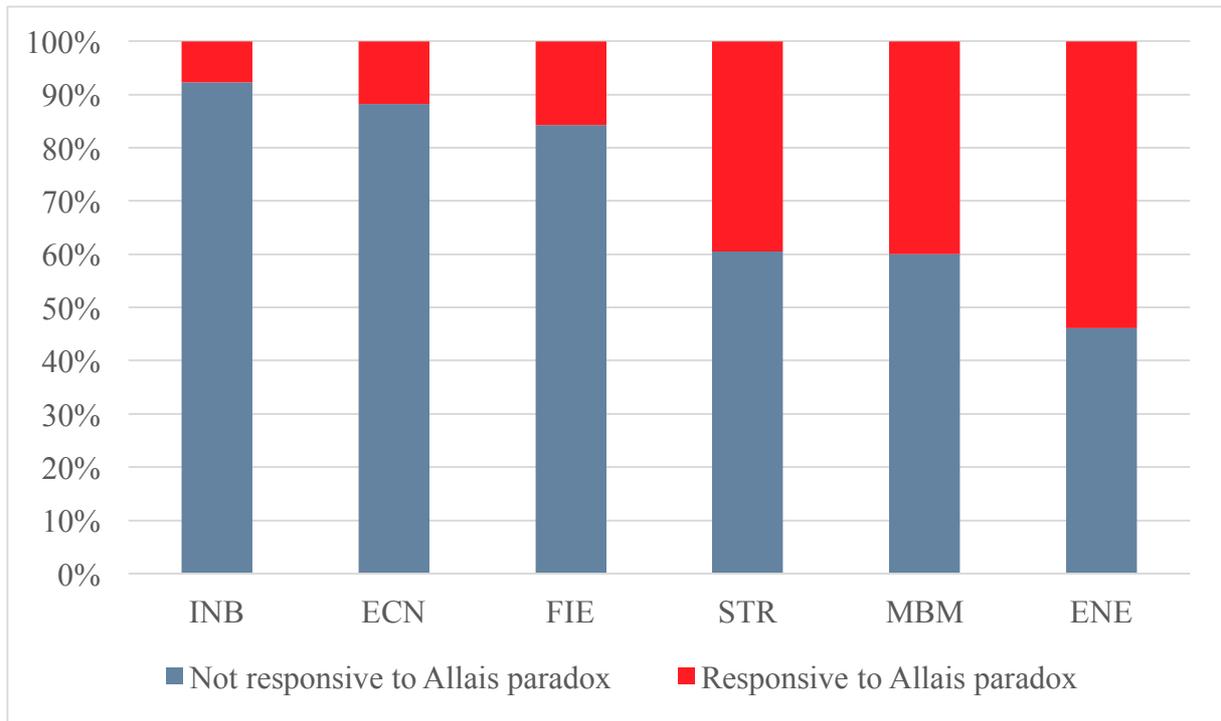
Figure 8 “Responsiveness to Allais paradox depending on the presence of negative experience”.



Figures 9 and 10 present the percentage of violating answers given by each major profile in Master’s program offered at NHH. The highest rate of responsiveness to Allais paradox is demonstrated by students within Energy, Natural Resources and the Environment profile (54%). Figure 10, however, shows that the percentage of violations within this profile is 5% lower than in the lottery with potential gain outcome. That means that some respondents within the profile are sensitive to the framing of the situation, and are eager to evaluate the alternative more thoroughly in the lottery with potential loss outcome. From the other side, the best performing students with the lowest rate of responsiveness to Allais paradox are enrolled in the Master’s program with the major profile in International Business. Only 8% of respondents within this profile are responsive to Allais paradox in the lottery with potential loss outcome.

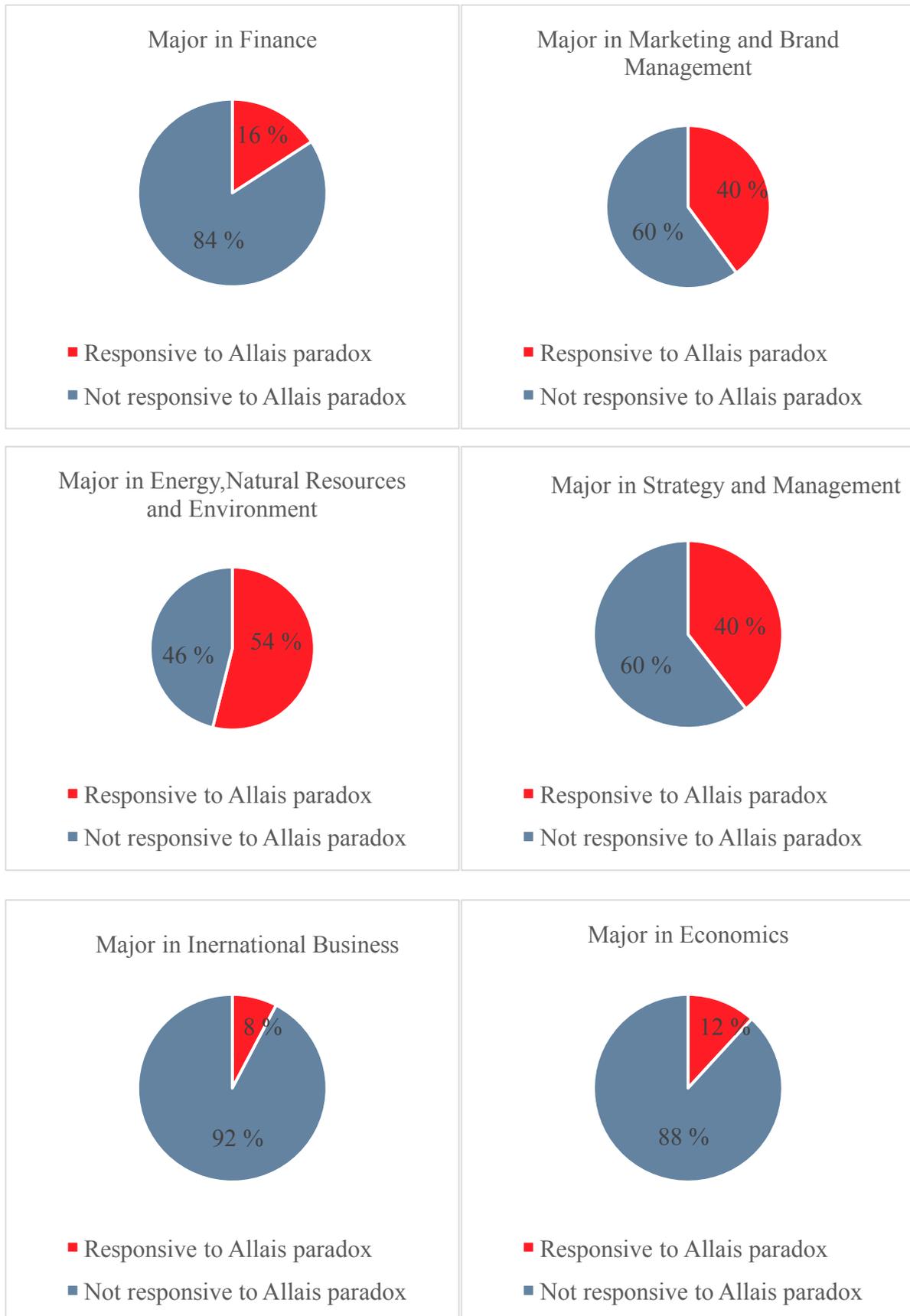
The results for the lottery with potential loss outcome do not propose the change in the group pattern that has been given earlier. Figure 9 and Figure 10 illustrate that the major profiles within the Master’s program can be allocated into two groups. The first group consists of the student with major profiles in Energy, Natural Resources and the Environment (54% of violations), Marketing and Brand Management (40% of violations) and the Strategy and Management (40% of violations). The group has performed less rational behavior, measured by higher percentage of answers which violate the independence axiom. The second group can be merged from the major profiles which have lower rate of the responsiveness to the Allais paradox. In this group are allocated students with major profile in International Business (8% of violations), Economics (12% of violations) and Finance (16% of violations).

Figure 9 “Responsiveness to Allais paradox based on the major profile in studies in the lottery with potential loss outcome”.



Moreover, it is important to note, that in a situation of potential loss outcome the percentage of responsive to Allais paradox students in most of the majors has significantly decreased. The reason for it can be the utility loss regardless the alternative chosen in the lotteries. That as a result facilitates the respondents to perform the analysis of the available alternatives more carefully in order to minimize the utility loss from the situation. Moreover, the students within International Business have performed better in the lottery with potential loss outcome compared to the rate of responsiveness in the lottery with potential gain outcome. However, the results obtained due to descriptive statistics have to be statistically examined within the proposed model in order to present statistically significant results.

Figure 10 “Responsiveness to Allais paradox within each major profile in the lottery with potential gain outcome”.



6.2.3 Regression results

In order to examine the effect of explanatory variables on the decision making in the lottery with potential loss outcome, two models are built. The first model summarizes the results of the relationship between variables Age and Gender and the responsiveness to Allais paradox. The second regression model is based on the equation 9, where in addition to the variables Age and Gender dummy variables of interest and the Agesq term are added. The regression results are summarized in the Table 12.

On contrast to the lottery with potential gain outcome, gender does not have statistically significant effect on the responsiveness to the Allais paradox. In the expanded model the significance of the Gender and Age variables has not been confirmed. The results reported in the Table 12 show that in the lottery with potential loss outcome age of the respondent has significant effect on the decision making in the model with only two explanatory variables. The regression predicts that older individuals are less likely to be among people responsive to Allais paradox in the lottery with potential loss outcome. The significant effect on the responsiveness to Allais paradox is estimated by variables Experience, Obligations, INB, FIE and ECN. The empirical study shows that the variables contribute to more rational behavior in the decision making under uncertainty. The results suggest that a respondent who is taking the Master's program within the major profile in International Business, Economics or Finance, has had negative experience with big financial loss or has self-imposed financial obligations in terms of children or student loan is less likely to be among respondents who have selected the answer combinations which violate the independence axioms. Thus, respondents who fall in the mentioned categories are less likely to be responsive to the Allais paradox. The models selected for the examination of the effect of explanatory variables on the responsiveness to the Allais paradox in the lottery with potential loss outcome are statistically significant. However, the expanded regression model fits the data better. In OLS regression model this can be illustrated by the value of adjusted R^2 , however, in the logit model pseudo R^2 is not valuable indicator for the goodness of fit, therefore, the conclusion is made based on the Log likelihood value, which shows the better fit to the data for the model with less negative Log likelihood value.

Table 12 “Estimated coefficients in basic and expanded model in the lottery with potential loss outcome”.

Variables	Lottery with potential loss outcome	
	Basic model	Expanded model
Gender	0.0368 (0.2907)	-0.1598 (0.3681)
Age	-0.2028*** (0.0635)	-1.0611 (0.9615)
Agesq		0.0181 (0.0180)
Experience		-1.4113*** (0.4050)
Obligations		-1.5054*** (0.3636)
FIE		-1.7186*** (0.6077)
INB		-1.9425*** (0.7062)
ENE		0.5175 (0.4945)
STR		0.1664 (0.4939)
ECN		-1.4722** (0.6481)
cons	4.2770 (1.6297)	15.9883 (12.7438)
Log likelihood	-140.8407	-107.2950
LR chi2	11.91***	79.00***
Pseudo R2	0.0406	0.2691
Number of observations	243	243

Note: * Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level; the standard errors reported in the brackets.

Since logit regression model can only predict whether the variable is more or less likely to have an effect on the dependent variable, the marginal effect over an average individual within a sample is conducted. The Table 13 shows the marginal effect of the variables on the responsiveness to Allais Paradox in a sample of the Master students in NHH-Norwegian School of Economics.

Table 13 “Marginal effect of the explanatory variables on the responsiveness to Allais paradox in basic and expanded model in the lottery with potential loss outcome”.

Variables	Lottery with potential loss outcome	
	Basic model	Expanded model
Age	-0.0400*** (0.0117)	-0.1526 (0.1369)
Agesq		0.0026 (0.0026)
Gender	0.0073 (0.0573)	-0.0230 (0.0528)
Experience		-0.2030*** (0.0533)
Obligations		-0.2165*** (0.0450)
FIE		-0.2472*** (0.0819)
INB		-0.2794*** (0.0966)
ENE		0.0744 (0.0706)
STR		0.0239 (0.0710)
ECN		-0.2117** (0.0911)

Note: * Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level; the delta method standard errors are reported in the brackets.

The estimated output given by Table 13 confirms the significance of variables Experience, Obligations, FIE, INB and ECN. The variables have significant negative effect on the probability of being responsive to Allais paradox. The greatest negative effect presented the dummy variable INB which takes the value 1 if the respondent is taking the major in International Business and 0 if the student is enrolled in any other major profile. The model suggests that a discrete change in the variable INB decreases the probability of being among responsive to Allais paradox individuals by 27.94%. The variable FIE, which takes the value 1 if the student takes the major profile in Finance, predicts that the responsiveness to Allais paradox drops by 24.72% for every additional individual within the sample enrolled in major in Finance. Moreover, the individual who has financial obligations is by 21.65% less likely to be giving the answer which illustrates the responsiveness to the Allais paradox. The independence axiom is by 22% less likely to be violated by students within Economics. The smallest effect is predicted by the experience, meaning that an individual who has experienced the financial loss has only 20% lower probability of being among responsive to Allais paradox students. The variables Gender, Age, Agesq, STR and ENE do not have statistically significant effect on the decision making in the expanded regression model. That is the reason why the interpretation of the estimated coefficients is omitted.

6.3 Summary of the empirical findings

243 Master's students from NHH-Norwegian School of Economics have participated in the survey created in order to test which factors contribute to the decision making under uncertainty in the lottery with potential gain and potential loss outcomes. For each lottery two regression models have been used. First, the basic regression model examines the effect of only two variables, Age and Gender, on the rationality of the decision making. After that, the regression analysis has been performed for the expanded model, which includes variables of interest for the research. The variables which have been added to the basic model proposed by Sanz de Acedo Lizarraga, Sanz de Acedo Baquedano & Cardelle-Elawar (2007) are Experience, Obligations, FIE, INB, ECN, STR, MBM and ENE. The variables have grouped respondents based on the major profile in studies, presence or absence of financial obligations and the previous negative experience. Moreover, the expanded regression model has been adjusted for non-linear relationship between variable Age and the responsiveness to Allais paradox by adding Agesq variable. All four regression models are statistically significant at 1% significance level, have no lack of fit and do not suffer from misspecification problem.

Firstly, the research found a decline in violations of independence axiom moving from the lottery with potential gain outcome to the lottery with potential loss outcome. That shows that people tend to make more careful examination of alternatives when the outcome brings the utility loss regardless the alternative chosen. Moreover, the results suggest that Master's students in NHH tend to overweigh small probabilities. Descriptive statistics shows, that the tendency of overweighting small probabilities is larger in the lottery with potential gain outcome than in the lottery with potential loss outcome. The descriptive statistics also found that female students, as well as male students, find risky option more attractive in both lotteries. Moreover, the study suggests that women tend to violate the independence axiom more often than men. The statistical significance of the variable has been proven in both models, basic and expanded, in the lottery with potential gain outcome, and in the basic model in the lottery with potential loss outcome. Thus, the results suggest that in the lottery with potential gain outcome, women are more likely to be in the group of respondents violating the independence axiom. Moreover, women are more responsive to Allais paradox in the model with only two explanatory variables in the lottery with potential loss outcome.

The empirical study has also found the significant effect of Age on the responsiveness to Allais paradox in the basic model with only two explanatory variables. The results show that the older individuals are less likely to violate the independence axiom and are less likely to be in the group of individuals who are responsive to Allais paradox in the model with two explanatory variables: age and gender. For the lottery with potential gain outcome, one year increase in Age reduced the likelihood of violations by 3.45%. In the lottery with potential loss outcome, the marginal effect of Age on the responsiveness to Allais paradox is 4%. However, in the expanded model the significant effect of Age on the rationality has not been found.

The importance of negative experience has been proven to have significant effect on the decision making in terms of financial lotteries. Both lotteries have shown that the individuals who have had negative experience, resulting big financial loss, have lower chances to violate independence axiom in financial lottery. The variable is significant throughout all the research at 1% significance level. The marginal effect of the variable estimated is 14.32 %, for the lottery with potential gain outcome, whereas in the lottery with potential loss outcome the responsiveness to Allais paradox is by 20.30% less likely from the respondent who has had the negative experience.

The self-imposed constraints which in the sample of students can be illustrated as elderly parents or children who have to be supported financially or student loan which has to be repaid have significant effect on the decision making in the lottery with potential loss outcome. The results show that an individual who has financial obligations is less likely to be in the group of students who violate the independence axiom in the situation of potential loss. The marginal effect estimated shows that the likelihood of responsiveness to Allais paradox is by 21.65% lower for the individual with financial obligations in the lottery with potential loss outcome. However, the effect of the variable in the lottery with potential gain outcome is insignificant.

The effect of the major in studies on the rationality in the decision making has been tested in the expanded version of the model and several conclusions can be made. Firstly, the six major profiles in NHH-Norwegian School of Economics can be divided into two groups. Group 1 consists of students within major profiles in Energy, Natural Resources and the Environment, Marketing and Brand Management and Strategy and Management. This group, based on descriptive statistics, has shown higher rate of violations of the independence axioms. However, the statistical significance of each of these majors has not been found meaning that the effect of the major within Energy, Natural Resources and the Environment and Strategy and Management profiles does not significantly differ from the major in Marketing and Brand management, which is the default setting for the expanded regression model. Group 2 has been formed from major profiles within International Business, Finance and Economics. The variables in the regression analysis are statistically significant and demonstrate the negative effect on the responsiveness to Allais paradox, meaning that the students from the major profiles within International Business, Finance and Economics are less likely to be in the group of students who have violated the independence axiom. Furthermore, the descriptive statistics suggests that the students within major profile in Economics perform the most rational decision making in the lottery with potential gain outcome, whereas students within International Business showed the lowest responsiveness to Allais paradox in the lottery with potential loss outcome. It is important to note, that one of the hypotheses formulated in this research states that the students with major profile in Finance have the least chances of being responsive to Allais paradox. The regression output confirms that individual who is responsive to Allais paradox has by 15.28% and 24.72% lower probability to be a student within Finance profile in the lottery with potential gain and potential loss outcome respectively. However, the estimated coefficient for dummy variable indicating students within International Business profile shows that respondents who take the major profile in International Business are even less likely to be

responsive to Allais paradox than the students within Finance in the lotteries with potential gain and potential loss outcomes. The results are statistically significant at 5% and 1% significance level. This implies that Finance students do not perform superior rational behavior among all six major profiles. Therefore, the effect of education in Finance has confirmed the hypothesis partly.

Table 14 “Marginal effect of the explanatory variables on the responsiveness to Allais paradox in the basic and expanded models in the lotteries with potential gain and potential loss outcomes”.

Variables	Lottery with potential gain outcome		Lottery with potential loss outcome	
	Basic model	Expanded model	Basic model	Expanded model
Gender	0.2302*** (0.0533)	0.1958*** (0.0559)	0.0073 (0.0573)	-0.0230 (0.0528)
Age	-0.0345*** (0.0118)	-0.1275 (0.1458)	-0.0400*** (0.0117)	-0.1526 (0.1369)
Agesq		0.0020 (0.0027)		0.0026 (0.0026)
Experience		-0.1432** (0.0600)		-0.2030*** (0.0533)
Obligations		-0.0842 (0.0576)		-0.2165*** (0.0450)
FIE		-0.1528* (0.0926)		-0.2472*** (0.0819)
INB		-0.1837** (0.0932)		-0.2794*** (0.0966)
ENE		0.1094 (0.0877)		0.0744 (0.0710)
STR		-0.0212 (0.0862)		0.0239 (0.0706)
ECN		-0.1820* (0.1017)		-0.2117** (0.0911)

Note: *Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level; the delta method standard errors are reported in the brackets.

7. Discussion

Discussion on the main findings is presented in this part of the paper. Reasons for the observed outcomes of the research are discussed and critical opinion is offered on whether the results obtained in this study confirm or contradict theories discussed earlier.

Firstly, it is necessary to discuss the importance of gender in decision making under uncertainty. The theories discussed earlier suggest that women are more likely to violate independence axiom, meaning that women are more likely to be responsive to Allais paradox (Hucks & Muller, 2012). The study has shown a significant effect of gender in the lottery with potential gain outcome. The reason for women to be responsive to Allais paradox in the lottery with potential gain outcome can be associated with the feeling that the individual faces: the feeling that there is nothing to lose. Therefore, the overconfidence discussed by Arch (1993) can be applied to female students in NHH. Moreover, the modern flow of feminism can also explain the violations of independence axiom by women. The equality that the society aims to achieve for both genders could also have affected the self-confidence of female students. The brevity in actions that women make, confirms the main reason for violations, which is overconfidence. However, the research findings contradict to theory proposed by Weber, Blais & Betz. The authors state that women are less likely to be engaged in risky lotteries. Even though higher percent of male students have selected the risky alternative as more attractive, the majority of female students also prefer risky alternative to safe option. On the other side, the effect of gender in the lottery with potential loss outcome has not been found. One possible explanation for that can be that, when facing a loss, people tend to evaluate and analyze the alternatives more thoroughly in order to minimize the utility loss. Therefore, it cannot be concluded that men are more rational in the decision making, since the significance of Gender variable on decision making has not been found in the lottery with potential loss outcome.

Even though the U-shape relationship proposed by Tymula et al. (2013) between the rationality and age has been found by descriptive statistics observing the relationship between responsiveness to Allais paradox and Age, the significance of the Age statistically has been proven only in the basic models of the lotteries. The research suggests that in the model with many explanatory variables the effect of Age is insignificant, meaning that other variables have greater impact on the responsiveness to Allais paradox than Age. The main reason for the variable to be insignificant in the expanded versions of the model is the fact that the data sample does not significantly vary in the age. The greatest number of respondents were in the age group

of 23-27, which makes it difficult to find any substantial difference in the decision making. However, the importance of Age variable in decision making has strong empirical evidence and is widely discussed, therefore, further recommendations concerning the use of the variable are mentioned in the Limitations part.

The link between previous negative experience and responsiveness to Allais paradox has been statistically proven in both lotteries. The results suggest that negative experience reduces the probability of an individual giving an answer which violates the independence axiom. Thus, there is a decrease in the likelihood of responsiveness to the Allais paradox, by 14.32% and 20.30% in the lottery with potential gain and the lottery with potential loss respectively. The reason for this relationship has been presented in numerous papers and is self-explanatory: people who have experienced utility loss before would be more careful in selecting between alternatives next time (Zeelenberg & Pieters, 2004; Ratner & Herbst, 2005; Roes & Summerville, 2005; Pieters & Zeelenberg, 2007; O'Connor, McCormack & Feeney, 2014). Moreover, I strongly believe that the negative experience strengthens individuals' ability to perform a more comprehensive analysis of the situation and include in the analysis of the current lottery some aspects that were ignored in the previous case which led to the financial and utility loss. Therefore, the study performed supports the view on positive effect of negative experience on the rationality in the decision making. Moreover, it is important to notice that the effect of the previous experience is significantly greater in the lottery with potential loss outcome.

The effect of financial obligations on the responsiveness to Allais paradox is ambiguous. The significance of the self-imposed constraints has been proven in the lottery with potential loss outcome, however, has not been found in the lottery with potential gain outcome. The reason for it can be found in the utility gain regardless the alternative chosen. The joined utility as well as the utility of both parties (decision maker and, for instance, children) will increase in any outcome of the situation as the lottery gives the opportunity to improve financial state of the respondent. Thus, in a situation leading to the utility gain regardless the alternative chosen, the self-imposed constraints do not significantly affect the decision. On the other side, the significance of obligations which have to be taken in account when the choice has to be made in a situation with potential loss outcome has been observed. The decision maker who has self-imposed constraints has by 21.65% lower chance to be in the group of people who are responsive to Allais paradox. The intuition behind this relationship is the same as for the lottery with potential gain outcome. The lottery with potential loss outcome states that regardless the

choice of the decision maker, the outcome of the lottery will be the loss of the utility. However, in this situation the decision maker has to select the alternative which will minimize the utility loss for him/herself, for the party which serves as a constraint and for the joint utility. Therefore, the decision made by the individual has to be analyzed more carefully. The study presents contradiction to the theory proposed by Kant (1788). The author states that there is a negative relationship between self-imposed constraints and the rationality of the decision maker. However, the empirical study of NHH Master's students shows that the self-imposed constraints in terms of financial obligations improve the rationality of decision maker and facilitates lower response to the Allais paradox.

The results obtained suggest that the major in studies has uncertain effect on the decision making. The descriptive statistics has found that the students within major profile in Economics are the least responsive to Allais paradox in the lottery with potential gain outcome. However, in the lottery with potential loss outcome the respondents taking major profile in International Business have presented the lowest responsiveness rate to the Allais paradox. The reason for it can be found in the main focus of the programs. The major profile in Economics covers the topics which improve students' ability to build a strategy which aims to acquire the greatest utility from the available alternatives. That is the reason why, in the lottery with potential gain outcome, students within Economics profile have found the strategy which creates the greatest utility for the decision maker and does not violate the independence axiom. However, the International Business profile program covers the topics of the successful investment strategies, as well as, failures in the business. The additional knowledge on how to minimize the negative effect in case of unavoidable loss improves the rationality respondents' in the decision making. Furthermore, the default setting for the major program in the expanded version of the model is the major in Marketing and Brand Management. The regressions performed have not found any significant effect of the major within Energy, Natural Resources and the Environment and Strategy and Management. Therefore, those majors in studies have no significant difference from the effect obtained from the major in Marketing and Brand Management. The greatest marginal effect on the responsiveness to Allais paradox has shown by the students taking the major profile in International Business. The results suggest that the responsiveness to Allais paradox is by 18.37% and 27.94% lower from a respondent within International Business compared with a respondent within Marketing and Brand Management major for the lotteries with potential gain and potential loss outcomes respectively. The effect of the major profiles in Finance and Economics have smaller but statistically significant effect on the rationality in the

decision making. This can be explained by the fact that courses within International Business, Economics and Finance are closely related. Moreover, the students from the majors in International Business have a higher probability of selecting courses within the major in Economics or Finance than students from Marketing and Brand Management. Therefore, students from International Business, Economics and Finance usually have more common courses covering the concepts of Rationality, Rational Choice and Expected Utility Theorem. Therefore, the students within International Business, Economics and Finance have lower probability to be responsive to Allais paradox. On the other side, one of the hypotheses made in this paper states that the Finance students have the lowest probability to be responsive to Allais paradox. The results have shown that respondents within major profile in Finance perform more rational decision making than students within Energy, Natural Resources and the Environment, Marketing and Brand Management and Strategy and Management profiles, however, do not perform superior decision making. The reason for it can be the main focus among the subjects chosen by students in Finance. Most of the courses in Finance and Economics majors are covering the mathematical intuition of the models. Moreover, the major in Finance is focusing on the fluctuations in financial markets. Therefore, the lack of basic theoretical understanding of the rationality decreases the marginal effect of the major in Finance. Thus, the superior performance of Finance students discussed by Cole and Shastry (2009) cannot be confirmed within this research. Nevertheless, the positive effect of the study programs which are closely correlated to the concepts of decision making, rationality and rational choice have positive effect on the decision making.

Overall, the results have revealed that Master's students at NHH confirm the statement that in the situation where the probability of winning is small, people tend to overweight the small probabilities. No matter the gender, Master's students at NHH find risky alternatives more attractive than the safe options in lotteries with potential gain and potential loss outcomes. Moreover, the respondents are more likely to violate the independence axiom in the lottery with potential gain outcome. This confirms the theory of overweighting small probabilities, discussed by Tversky & Kahneman in the paper "Advances in Prospect Theory: Cumulative Representation of Uncertainty" published in 1992. The feeling of the utility gain regardless of the chosen alternative relaxes respondents and lead them into making the choice without analyzing the rationality of the choice. On the other hand, the lottery with potential loss outcome facilitates respondents to think carefully before making the choice, and therefore, make more rational decisions.

The models discussed throughout the paper are valuable and statistically significant for examining the relationship between explanatory variables and the responsiveness to the Allais paradox. Moreover, the expanded model which has been proposed in this research demonstrates a better fit to the data than the model with only two explanatory variables. Therefore, the study presented on the effect of the variables Gender, Age, Experience, Obligations and major profile within education program to the responsiveness to Allais paradox creates the value for future development of the topic and contributes by presenting the results obtained from the sample of Master's students in NHH-Norwegian School of Economics.

8. Limitations

Nevertheless, the evidence of good fit of the regression model to the data and significance of the regression models have been presented, the research has certain limitations.

Firstly, there are approximately 3 000 students studying in NHH - Norwegian School of Economics. If a half of the people are students who are enrolled in Bachelor's program at NHH, only 16.2% of Master's students have responded to the questionnaire. The low response rate can be explained by several arguments. The first argument is connected to unwillingness of students to participate, since questionnaire is usually associated with long survey which has no value for the respondent. The second possible reason is the lack of time. NHH is ranked as one of the best business schools in Norway, therefore if the student wishes to successfully complete the course, there is much time which has to be spent on studying. Therefore, another assumption which can be made explaining the low response rate is that the Master's students in NHH have prioritized the studies for their courses more than the participation in the research. The same reasoning can be used for the difference in the quantity of responses per major profile given by students. The quantity of assignments, course works and other extra learning processes is unevenly distributed across the six major profiles. Therefore, students from different major profiles could have different amount of time which they could contribute to the participation in the research. Hence, the research could observe the general effect of the education on the decision making, as well as, get marginal effect for the responsiveness to the Allais paradox based on the responses of 16.2% of Master's students from NHH.

The second limitation for this research concerns the explanatory variable Age. Despite the solid empirical background, the study has found no significant effect of Age on the responsiveness to the Allais paradox in the expanded regression models. The reason for it can be found in the small sample size with the small age interval. The information has been collected from the respondents who are enrolled in the Master's program, meaning that average age within the sample is 26 years. That is the reason why further investigation which includes Bachelor's program students and working personnel from NHH could be conducted.

Nowadays, in Norway many students use the subsidy from the government which is called Norwegian State Educational Loan. This is the attempt of Norwegian Government to equalize the rights and opportunities for every person to have education regardless the economic and social background, age and gender. The student loan on respectable conditions is issued to

many people in order to ensure that every person in the society has opportunity for development. The information concerning the rules of the loan repayment states that the interest rate is applied only on the loans of the students who have completed their studies. That means that the student during the education process does not have to be concerned about the repaying the loan. Moreover, the interest rate which is used for the loan is in the range of 2-5% depending on the length of the studies. Furthermore, the loan has to be repaid by the age of 65, meaning that there is an opportunity to negotiate on the payment amount which does not harm the living costs of the individual (Lånkasse, 2017). Therefore, the student loan does not have the same effect on the decision making of an individual as the feeling of responsibility of having a child or elderly parents who requires financial support.

Another aspect which has to be accounted for in the further investigation is the assumption made in this paper that every individual who has had a negative experience has made certain conclusions based on the actions which contributed to the utility loss. Unluckily, it does not always hold. Some people do not evaluate the negative experience as an opportunity to learn from mistakes. Therefore, despite the statistical significance of the variable in this research, for more accurate examination additional tests have to be performed. The additional tests will give an opportunity to examine whether an individual has ability to learn from the mistakes and investigate to what extent the person is responsive to the feeling of emotional regret.

9. Conclusion

The paper presents a research conducted over 243 students enrolled in Master's program in NHH (Norwegian School of Economics). The study emphasizes the examination of the main factors which facilitate the violation of the independence axiom, also known as Allais paradox. Moreover, the research contributes to the study of Allais paradox by presenting the analysis of the main factors in the violation of independence axiom by students with business education background.

Within the research the most important concepts of the rational decision making were discussed and the empirical background on the selected variables was presented. The paper also presented the diagnostics for the selected models in order to confirm the reliability and the significance of the study. For the study the basic and expanded models had been created, which had examined the responsiveness to Allais paradox in two lotteries: the lottery with potential gain outcome and the lottery with potential loss outcome. The basic model captured the significance of Age and Gender in the decision making under uncertainty, whereas the expanded model was used to perform the analysis for additional variables which could affect the responsiveness to the Allais paradox. The empirical research highlighted the importance of negative experience, presence of financial obligations and the major profile in Master's program on the rationality in the decision making.

The empirical study showed a decrease in the rate of responsiveness to Allais paradox moving from the lottery with potential gain outcome to the lottery with potential loss outcome. Moreover, the hypothesis which states that women are more likely to violate the independence axiom than men could not be rejected within the lottery with potential gain outcome. The statistical significance of gender on the decision making had not been proven in the lottery with potential loss outcome. Therefore, the claim that women are less rational in the decision making than the men could be confirmed partly. The study had also found that even though most of the respondents found the risky alternative more attractive regardless the lottery they had participated in, women were more likely to select safe alternative than men.

Furthermore, the descriptive statistics had confirmed the claim made in the paper of Tymula et al. (2013) which states that the rationality has inverted U-shape with age. The responsiveness to Allais paradox had inverted U-shape in age in this study, however, the significance of the factor had been confirmed only in the basic regression models with two explanatory variables.

The significant effect of the previous experience had been found. Therefore, the people who had experienced the utility loss from unsuccessful investment or the lottery with big financial loss have lower chances to violate the independence axiom compared with individuals without negative experience. The reason for it could be found in the improvements in the analytical ability of the respondent who has had the negative experience. That as a result served the basis for the better analysis of the upcoming situation which included the decision making under uncertainty.

The empirical study had also discovered the link between financial obligations and the responsiveness to Allais paradox in the lottery with potential loss outcome. The results suggested that self-imposed constraints in terms of elderly parents, children, student loan etc. have negative effect on the responsiveness to Allais paradox in the lottery with potential loss outcome. The explanation had been found in the feeling of responsibility which facilitated the decision maker to perform more careful analysis of the alternatives compared with the situation with potential gain outcome.

Another main question which had been addressed within the paper was whether the major profile of the studies have any effect on the decision making. The results suggested the negative effect of major profiles within International Business, Finance and Economics on the responsiveness to Allais paradox. The respondents who were enrolled in Master's program with major profile within Economics, International Business and Finance performed more rational decision making and had lower probability to be in the group of students who had violated the independence axiom showing the response to the Allais paradox. However, the study had not shown that the students within Finance profile had illustrated the most rational decision making.

Even though the paper presented the comprehensive study of the selected topic, the limitations of the research were discussed. The limitation discussed and notes proposed could become the basis for the future research.

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Appendices

Appendix 1 “Questionnaire for Master students in NHH-Norwegian School of Economics”.

Hello. I am writing my Master’s thesis in Behavioral Finance, therefore I would be very happy if you agreed to participate in my research. The purpose of the study is to find out which characteristics does the responsive to Allais paradox individual has given the commerce background education. The answers from this questionnaire are anonymous and will be used only for this particular research.

1. Your gender:

Man

Woman

2. Your age:

3. Your major profile at NHH:

4. Did you ever had a big monetary fail that disappointed you (e.g. lottery that led to big financial loss or unsuccessful investment etc.)?

Yes

No

5. Do you have any financial obligations (elderly parents/children, student loan, investment made etc.)?

Yes

No

6. You are asked to participate in a lottery. Which of the given alternatives you would prefer?

Alternative A: 100% chance of winning NOK 1000.

Alternative B: B 10% chance of winning NOK 5000, 89% chance winning NOK 1000 and 1% chance of winning nothing.

7. You are asked to select one of the alternatives for the lottery. Which do you prefer?

Alternative A': 11% chance of winning NOK 1000, 89% winning nothing.

Alternative B': 10% chance of winning NOK 5000, 90% winning nothing.

8. You are experiencing unavoidable loss, but have an opportunity to accept the lottery. Which of the alternatives you find more attractive?

Alternative A: Sure loss of NOK 1000.

Alternative B: 80% chance of losing NOK 5000 and 20% chance of losing nothing.

9. Which of the following alternatives seems more attractive for you in case of given lottery?

Alternative A': 10% probability of loss NOK 1000, 90% of losing nothing.

Alternative B': 8% probability of loss NOK 5000, 92% probability losing nothing.

Your participation in the research is very appreciated. Thank you for your time!

Appendix 2 “Probabilistic beliefs of preferences”

- 1) $1 \geq p(X) \geq 0$ for any outcome x
- 2) $1 = p(X)$ if outcome x is certain
- 3) $p(X_i \text{ or } X_j) = p(X_i) + p(X_j)$
- 4) $p(X_i \text{ and } X_j) = p(X_i) P(X_i|X_j)$

Source: Cameron & Trivedi (2009)

Appendix 3 “Assumptions for Logit model”

- 1) The outcome or the dependent variable has to be dichotomous (answer the question yes or no);
- 2) There should be no outliers in the data set;
- 3) There should be no multicollinearity among the predictors.

Source: Cameron & Trivedi (2009)

Appendix 4 “Difference between Logit, Probit and Linear Probability models”.

Model	Probability $p = \Pr(y=1 x)$	Marginal effect $\partial p / \partial x_i$
Logit	$\Lambda(x'\beta) = \frac{e^{x'\beta}}{1 + e^{x'\beta}}$	$\Lambda(x'\beta)\{1 - \Lambda(x'\beta)\}\beta_j$
Probit	$\Phi(x'\beta) = \int_{-\infty}^{x'\beta} \phi(z) dz$	$\phi(x'\beta)\beta_j$
Linear Probability Model	$F(x'\beta) = 1 - \exp\{-\exp(x'\beta)\}$	$\exp\{-\exp(x'\beta)\}\exp(x'\beta)\beta_j$

Source: Cameron & Trivedi (2009)