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Universidade de Lisboa

MASTER

IN FINANCE

MASTER'S FINAL WORK

DISSERTATION

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MARIA LUÍSA GOMES PEREIRA

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SUPERVISION:
PROFESSOR TIAGO GONÇALVES

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ABSTRACT

Being vulnerable to behavioral biases influences our financial decisions and can lead to sub-optimal financial judgment. Poor financial literacy can lead to the same result. The aim of this paper is to understand whether we can mitigate behavioral biases by ensuring a formal education in finance. This research studies the impact of both personal aspects and financial literacy level on the propensity to incur on behavioral biases. We also aim to assess if there is a positive correlation between behavioral biases.

We create a survey to measure both financial literacy and behavioral biases. Everyone who has a master's degree in finance or in a similar field or is attending one was eligible for the study. We find that household characteristics, such as income and number of members, play a significant role in predicting behavioral biases even within individuals with a formal financial education. However, we can affirm that the influence of personal aspects, as gender or age, on behavioral biases can be mitigated. We find no effect of the actual level of financial literacy on behavioral biases. The exception would be a high level of actual knowledge will mitigate overconfident behavior. We conduct further analysis for three additional measures of the level of financial literacy. In regard to the influence of demographic factors, we obtain comparable results using these additional variables. The household variables continue to be statistically relevant in predicting several biases. We continue to observe no apparent strong influence of financial literacy on behavioral biases as suggested in the literature. Finally, we noticed no differences in the findings when we included two new factors to the model that proxied education and experience.

KEYWORDS: BEHAVIORAL BIASES; FINANCIAL LITERACY; DEMOGRAPHIC ASPECTS; EDUCATION; PORTUGAL.

JEL CODES: G40; G41; G53; G51

RESUMO

Ser vulnerável a desvios comportamentais influencia e pode condicionar negativamente as nossas decisões financeiras. A fraca literacia financeira pode levar ao mesmo resultado. O presente estudo avalia se estes desvios comportamentais podem ser mitigados, quando garantida uma educação formal em finanças. É estudado o impacto de aspectos demográficos e o nível de literacia financeira na propensão para desvios comportamentais. Também é analisada a existência de uma correlação positiva entre desvios comportamentais.

Foi criado um inquérito que visa a medir o nível de literacia financeira e a propensão para desvios comportamentais. Todos os participantes que têm ou estão inscritos num mestrado em finanças ou num outro semelhante foram elegíveis para o estudo. Descobrimos que as características do agregado familiar, como o rendimento e o número de membros, desempenham um papel significativo na previsão dos desvios comportamentais, mesmo em indivíduos com reconhecida educação financeira. No entanto, podemos afirmar que a influência dos aspectos demográficos, como o género ou a idade, sobre os desvios comportamentais pode ser mitigada. Não encontramos efeito do nível de literacia financeira sobre desvios comportamentais. Com exceção, um alto nível de conhecimento financeiro mitiga o comportamento excessivamente confiante. Foram realizadas análises complementares usando três medidas adicionais do nível de literacia financeira. Em relação à influência dos fatores demográficos, obtemos resultados similares utilizando estas novas variáveis. As características do agregado familiar continuam a ser estatisticamente relevantes na predição dos vários desvios comportamentais. Não é encontrada nenhuma aparente grande influência da literacia financeira nos vários desvios comportamentais, como sugerido na literatura. Por fim, não são observadas diferenças nos resultados quando são adicionados dois novos fatores ao modelo que espelhavam a educação e a experiência.

PALAVRAS-CHAVE: DESVIOS COMPORTAMENTAIS; LITERACIA FINANCEIRA; ASPETOS DEMOGRÁFICOS; EDUCAÇÃO; PORTUGAL.

JEL CODES: G40; G41; G53; G51

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TABLE OF CONTENTS

LIST OF FIGURES

GLOSSARY

US – United Stated of America

OCDE - Organization for Economic Co-operation and Development

CEO – Chief Executive Officer

CFO – Chief Financial Officer

COO – Chief Operating Officer

CMVM - Portuguese Stock Exchange Regulator

FLI – Financial Literacy Index

PCA - Principal Component Analysis

VIF – Variance Inflation Factor

1. INTRODUCTION

The human being is undoubtedly affected by his emotions. As so, every decision we take is influenced by our feelings or instinct. Consequently, the old idea that investors are rational wealth maximizers is, consequently, outdated. Kahneman and Tversky (2013) recognized that an investor does not behave rationally when dealing with risk, probability, and uncertainty. As a result, investors are vulnerable to behavioral biases that might result in a poor financial judgment and suboptimal decisions (Saraiva and Gonçalves, 2022). Several studies have associated personal factors about investors with the predisposition for behavioral biases, among them the level of financial literacy. The behavioral biases that we will consider in our study are Loss Aversion, Gambler's Fallacy, Disposition Effect (in terms of loss and gains), Ostrich Effect, and Overconfidence.

The main question that we will seek to answer is: Can a formal financial education in finance mitigate the proneness to behavioral biases in investing decision-making? Therefore, we want to understand if the impact of personal characteristics like gender, age, or the income of the household will be mitigated by assuring a sample with a high level of education. We will also understand if the level of financial knowledge will impact the proneness to behavioral biases. Lastly, we will answer one last question: Do we tend to behave consistently? More rationally or more intuitive?

We use the data from our own survey to assess the level of financial literacy and the existence or not of behavioral biases. The level of financial literacy was measured using sixteen technical questions with different difficulty degrees. We assessed behavioral biases by applying traditional measures based on prior research. We also collected some personal characteristics of the participants. Everyone who holds or is enrolled in a master's degree in finance, or a related field was eligible to participate in the survey, which was conducted online from the beginning of June until the end of July 2022. We constructed several indices for evaluating financial literacy and providing extra robustness.

We found a clear disassociation between demographic factors and behavioral biases when compared with the past literature. Personal characteristics like gender, age or risk attitude of the individual will not influence the proneness to behavioral biases as described throughout the literature, in presence of individuals' formal financial education. Although, we could observe that there is a strong effect of the household characteristics mainly regarding disposition effect concerning losses, ostrich effect, and overconfidence. Moreover, we could not consistently prove that the level of financial literacy alleviates or enhance behavioral biases.

As an exception, we found that overconfidence is impacted positively by how much we think we know and negatively by how much we really know. We could also not find that people act in a consistent way, so, suffering from one behavioral bias won't mean that we suffer from others. However, we find a clear connection between loss aversion and gambler's fallacy.

In our additional analysis, we include in our model both education and experience. We wanted to check if having completed the master's degree or being experienced in financial products could influence our results. However, the results were similar to the ones already reported. Therefore, these two variables don't seem to influence our model.

The contribution of this study is to provide evidence about the power that formal education has in sound investment decisions. New results about the relationship between personal characteristics, behavioral biases, and financial literacy are exposed. We extend the research by considering a sample that has a formal education in finance, which, to the best of our knowledge, has not been done before, particularly in Portugal.

This study is structured as follows: in section 2, we explore the existing research on behavioral biases and how it relates to investors' personal characteristics and financial literacy. Section 3 describes the hypothesis under study and our expected findings. In section 4, we describe our data collection and the methodology used to construct the variables of interest. Following section 5, we described the model to be employed and, in section 6, we present the results of our analysis. Lastly in section 7, we discuss our findings and present the main conclusions.

2. LITERATURE REVIEW

The beginning of the realization of the importance of financial literacy goes back to 1787. Jonh Adams, second president of the US, connected America's problems to "downright ignorance of the nature of coin, credit, and circulation".

Although many studies have been conducted since then, there is not a standardized definition of financial literacy yet. Financial literacy can be simply defined as what society should know to achieve successful financial decisions (Mandell, 2006). The Organization for Economic Co-operation and Development (OCDE) goes further. Beyond knowledge, financial literacy also aggregates attitude, skill, awareness and behavior required to settle on safe and solid financial decisions and, in the end, reach individual financial wealth. Mason and Wilson (2000) refer to financial literacy as the ability to acquire, comprehend and assess the relevant data to make strong and informed financial decisions, while Jump $tart Coalition defines

financial literacy as the competence to use the knowledge and abilities to manage efficiently and safely financial resources of their own.

With the current increasing complexity and variety of financial products, the knowledge of financial concepts is critical to make informed financial decisions. However, there is a strong consensus that the lack of financial literacy is still prevalent around the world (Lusardi & Mitchell, 2011), even in economically developed nations or between heads of departments. Anderson et al. (2017) found in a study which focused in 5.814 American Linkedin users that more than one-third of CEOs, CFOs and COOs couldn't respond to 5 basic questions about finance. Furthermore, Portugal - the focus of this study - is the nation with the worst financial literacy among the euro area members (Klapper & Lusardi, 2020).

The lack of financial literacy leads to bad decisions (Lusardi & Tufano, 2015). In fact, less literate individuals are more prone to depend on debt with high-interest rates, fees and charges. Likewise, they don't plan retirement, ending up saving less and, therefore, collecting less wealth (Anderson et al., 2017). These investors are as well considerably less prone to participate in the stock market (Van Rooij et al., 2011).

Along with this study, many others have been carried out in order to evaluate the level of financial literacy across the world. In extant literature, there are large disparities in financial literacy among individuals, which are based on personal characteristics.

Most of the literature agrees that there is an universal gender gap in financial literacy. Financial illiteracy is not only prevalent, but it is also extremely serious between women of any age. Lusardi et al. (2010) found that gender is a strong predictor of financial literacy, assigning more literacy to men. Although, some authors disagree, Ates et al. (2016) recognize that females have a higher financial literacy than males. At the same time, Bağci and Kahranan (2020) defend that there is no significant relationship between gender and financial literacy.

Among the youngest, Chen and Volpe (1998) surveyed 924 college students to analyze their personal financial literacy level, and it was found that female respondents had lower knowledge than males. Despite the fact, Mandell (2008) affirms that female college students have a higher literacy level than males in the same situation.

These mixed results can be attributed to women's lower levels of confidence. Bucher-Koenen et al. (2021) conducted research that tried to determine and understand if women have less confidence in their knowledge and, if so, whether this is the foundation of the gender gap in what finance matters. The authors demonstrated that when "don't know" was a valid option in multiple-choice finance questions, the financial knowledge gap between genders increased

since women ended up choosing "don't know" as an answer. Nevertheless, when the respondents were forced to pick an answer, the gap between genders was smaller. Females, knowing the correct answer, are only confident in answering when pressured with the absence of a "don't know" option. Whereas the authors recognize that women have a lower financial literacy than men, one-third of the difference is assumed to be due to a lack of confidence.

Existing literature also illustrates that the level of education has a positive effect on financial literacy. According to Albeerdy and Gharleghi (2015), education will enhance society´s financial literacy for both men and women. In fact, it is argued that a person with a lower level of education is less likely to respond correctly to financial questions (Abreu & Mendes, 2010; Lusardi & Mitchell, 2014; Van Rooij, et al., 2011). Furthermore, people that took business majors are more financially literate than those who majored in non-business (Chen & Volpe, 2018). Chen and Volpe (2002) add those female participants benefit more from having a business major than male participants. Albeerdy and Gharleghi (2015) also found that education has a significant relationship with financial literacy among university students, which makes university education the most effective way to improve students´ financial literacy. Specifically, financial knowledge increases substantially with economics and finance education (Bateman et al, 2012).

Age also impacts the levels of financial literacy. Chen and Volpe (1998) found out that participants over 40 are expected to have more knowledge, not simply because they are older but because of previous experience in personal finance. This is coherent with a learning-by-doing mechanism, where individuals learn by experience (Frijns et al, 2014). Klaper and Lusardi (2020) admit that the influence of age in financial literacy differs across countries. In developed countries, the young and the oldest have low financial literacy, with the highest rate of financial literacy concentrated in the age group of 36-56. On the other hand, in developing nations, the level of financial literacy decreases with age, making the youngest the ones with the highest literacy.

The investor's financial awareness can be assessed by comparing the accurate measure of financial literacy and the knowledge that they think they have about finance. In fact, there is usually a discrepancy between self-assessed literacy and real knowledge.

Lusardi and Tufano (2015) notice that, even though between 1.000 participants the majority were pretty confident about their financial knowledge with a given self-assessed score of 5 or 6 out of 7, the effective score of financial literacy among these participants was 4,88. In another study, Lusardi and Mitchell (2017) found a strong correlation between self-assessed

and actual basic financial literacy, which increases if we consider a more advanced level. Bateman et al (2012) found the same conclusion. There is a high level of self–reported financial knowledge, principally among men. Although, the self-assessed financial literacy follows the real financial literacy when it comes to women. They know that their knowledge is limited.

Regarding education, Willows (2019) denotes that those who have a higher degree of education know they have a higher financial literacy than those with only the secondary level. This does not happen when the author analysed the age of investors. The older investors considered that they have a much higher knowledge about finance than they really have.

The popular theories in the literature, such as Efficient Market Hypothesis (Fama, 1970) and the Modern Portfolio Theory (Markowitz, 1952), argue that the markets are completely efficient and that investors are rational wealth maximizers.

Although, the idea that financial markets are always efficient and that price fluctuation represents genuine information is outdated (Shiller, 2003). Indeed, Kahneman and Tversky (2013) recognized that the actual behavior of individuals is not rational when confronted with decisions involving risk, probability, and uncertainty.

Ongoing literature exhibits that financial decisions may be affected by numerous behavior biases based on feelings or instinct. Behavioral Finance studies finance from a more extensive point of view, including insights from psychology and sociology (Shiller, 2003). This theory tries to perceive how emotions and cognitive errors can persuade the behavior of individuals (Kengatharan, 2014), leading to sub-optimal decisions and inaccurate judgment, completely diverging from the idea of rational human beings.

By enabling behavioral biases to influence their decision-making, each individual can substantially jeopardize their capital. Among several biases, an inclination towards error (Shefrin, 2003), which can indeed lower our financial well-being, Loss Aversion, Gambler´s Fallacy, Disposition Effect, Ostrich´s Effect, and Overconfidence are the ones under study.

The concept of loss aversion was developed by Tversky and Kahneman (1979). The authors propose an alternative model, prospect theory. This theory defends that a loss origins a greater emotional impact on a person than an equivalent gain. Thus, contradicts the maximization of the utility in which an investor should choose the investment that maximizes his level of wealth.

The principal repercussion of loss aversion is a lower utility associated with giving up a valuable product when compared with getting it. This is referred to in the literature by the Endowment effect (Thaler, 1980). Accordingly, people tend to value more an owned good than

its market value. All of this means that people will quite often lean toward the status quo over changes that might bring losses, wasting the possibility of good outcomes (Rabin, 1998). This unreasonable aversion to losses has irrational behaviors as a consequence and can lead to suboptimal decisions. Indeed, when the prices are increasing, the number of trades will in general be higher than when the prices are in decline (Shefrin & Statman, 1985).

Regarding how this bias is affected by demographic characteristics, Johnson et al (2006) found in a survey with 360 participants that the younger are more loss averse, as well as the more educated. Although, the author concludes that gender is not a predictor of loss aversion. Arora and Kumari (2015) disagrees and defends that women show more loss aversion. Renu Isidore and Christie (2018) found that a higher income will enhance the probability to suffer from loss aversion. The more experience an investor has, the higher will be the degree of loss aversion (Bokhari & Geltner, 2011).

Confidence is a key to success in various aspects of life. Although, overconfidence can be an issue. Overconfident people think they can do better decisions and view themselves in a more positive light than others (Daniel et al, 1998). These individuals overestimate their capabilities, their knowledge, and their hopes for the future (Barber & Odean, 2001). The principal consequence is that overconfidence generates extra trading and lower expected utility (Odean, 1998). Indeed, Barber and Odean (1998) found that investors who trade more aggressively perform worse than those who have a lower volume of trading.

Regarding individual characteristics, typically men experience more overconfidence than females, mainly in finance (Barber & Odean, 2001). Furthermore, Bhandari and Deaves (2006) found in a study involving 1.871 Canadians that higher levels of education are associated with higher overconfidence. Also, people that are approaching retirement are more overconfident. This is consistent with the finding of Renu Isidore and Christie (2018), a higher income will increase the probability of overconfident behavior. Following this idea, more experienced investors frequently behave in an overconfident manner (Chen et al, 2004)

Galai and Sade (2003) was the first to refer to the ostrich effect. The ostrich effect is the investors' attempt to avoid risky financial positions by ignoring they exist. Another definition for the ostrich effect, used by Karlsson et al (2009), is the tendency of investors to

monitor their portfolios more regularly when the stock market is up than when it is performing poorly, avoiding negative information.

Regarding individual characteristics, ostrich behavior is more likely to be displayed in men and is reported to exist a positive relationship between ostrich tendencies and age (Sicherman et al, 2012). So, the more prone to experience this effect are men approaching retirement age.

The first mention of what is now known as gambler´s fallacy was made by Laplace in an essay where he analyses the "illusions in the estimation of probabilities". Later on, Tversky and Kahneman (1971) defined the gambler´s fallacy as a "misconception of the fairness of the laws of chance". This bias describes how individuals overstate the degree to which a short random sequence should reflect the entire population´s probability distribution. Therefore, long runs with the same output are not viewed as representative of an expected random outcome (Ayton & Fischer, 2004). Simplifying, a person when confronted with the same outcome over and over again will assume that the contrary outcome is more likely to happen.

Croson and Sundali (2005) studied the bets placed at the game of roulette in a casino in Nevada, including 139 players placing 24.131 bets. Eventually, the results showed that after 5 times of the same output, the players were more likely to bet against it. Indeed, 85% of bets after 6 outputs of the same type are congruent with the gambler fallacy. These results are in accordance with the finding of Terrell (1994) and Cloteelter and Cook (1991).

Although there is a great amount of literature regarding the gambler's fallacy using casinos and lotteries, studies about the connection between this bias and the stock market are scarce. Jonhson and Tellis (2005) found that gambler´s fallacy bias is associated with the duration of the company´s results. Initially, as a positive run increases, buying is the preference. Although, as this run lengthens, investors prefer to sell the stocks. Similarly, when a negative run starts, selling is the inclination. However, when the duration of the bad results increases, the investors prefer to buy.

Regarding how demographic factors can influence the predisposition to incur in gambler´s fallacy, Suetens and Tyran (2012) found that men are less likely to choose some lottery number equal to the last drawn. The same finding was made by Marmurek et al. (2015) regarding university students. Stockl et al. (2015) did not find any difference between men's and women's proneness to gambler´s fallacy. Regarding income, Williams at al. (2022) found that lower income is predictive of a higher propensity to gambler's fallacy. On the other hand,

Renu Isidore and Christie (2018) didn't find any relationship between the income available and the proneness of this bias. Hon-Snir et al. (2012) discovered that a more experienced investor will have a lower likelihood of experiencing the ostrich effect.

Regarding the disposition effect, it was first discussed by Shefrin and Statman in 1985 based on Kahneman & Tversky´s (1979) prospect theory, mental accounting, regret aversion, and self-control. They defined this bias as the tendency of investors to "sell winners too early" and hold "losers too long". Thus, investors tend to sell assets that have increased in value too prematurely, in order to ensure a profit, while holding on losing investments, in hopes of recovery. Garling et al. (2017) concluded that if sufficient investors are going through disposition effect bias this can boost an upward price trend and dissipate a descending trend of prices. All this is motivated by the anticipated regret. Investors wish to avoid the regret of losing money or from earning too little. Indeed, regret is an emotion linked to responsibility (Summers & Duxbury, 2007, 2012).

Regarding demographic features, women are more prone to suffer from this bias. Being more loss averse, females are more reluctant to realize losses, and, consequently, more propense to a higher disposition effect (Frino et all, 2015). Furthermore, older investors also exhibit a greater disposition effect than younger (Cheng et al, 2013). However, being an experienced investor can lower this behavioral bias (Dhar & Zhu, 2002). Vaarmets et al (2019) concluded that those who have a master´s or doctoral degree are less prone to the disposition effect bias. Therefore, the disposition effect can be mitigated by a higher level of education. However, the author adds that education in finance can, indeed, increase the bias. Dhar and Zhu (2002) found that lower levels of income are related to a higher predisposition to disposition effect, which is in accordance with Weber and Welfens (2008). They found that investors with a higher income are more probable to sell their losing investments.

Financial literacy is a critical factor when the ability to make wise financial decisions comes into question (Lusardi & Tufano, 2015). On the other hand, behavioral biases can cause ineffective decisions and fallacious judgment (Kengatharan, 2014). The literature published so far states that financial literacy influences the presence of behavioral biases. However, the nature of this relationship is quite contradictory. There is no consensus: a high level of financial literacy may mitigate or potentiate depending on the behavioral bias in the analysis. Some authors found that financial literacy has a negative relationship with the disposition effect (Baker at al., 2018), overconfidence, loss aversion, and gambler's fallacy (Ates et al., 2016;

Rassol and Ullah, 2019). On the other hand, some defend that financial literacy can have a positive relationship with behavioral biases. Hayat and Anwar (2016) found that greater financial knowledge can contribute to overconfidence and Ates et al. (2016) reported that financial literacy influences positively the probability of being in the presence of overoptimism, confirmation, and representativeness, some other examples of behavioral biases that are beyond the scope of this study.

3. RESEARCH QUESTION AND HYPOTHESES

The purpose of this thesis will be to comprehend and evaluate the relationship between financial literacy, behavioral biases, and demographic factors. In the past literature, there is a clear consensus that demographic factors, behavioral biases, and financial literacy are connected. The goal of this study is to evaluate if this influence can be reduced by ensuring formal financial education. The main question to be answered is: Can a formal education in finance mitigate the proneness to behavioral biases in investment decision-making? Therefore, this study aims to demonstrate that education can reduce the impact of personal factors on the propensity to behavioral bias. Furthermore, we will seek to understand if a higher degree of formal financial education, and consequent, an expected high financial literacy could impact behavioral biases in investment decisions.

Firstly, we must determine the potential drivers of behavioral biases. This hypothesis is denoted H1. Here, we look at the impact of demographics factors and of financial literacy on each behavioral bias. Although the past literature states a clear influence of demographic aspects, when a formal education is guaranteed, we anticipate that the effects of gender, age, household size and household income will have a much smaller impact on behavioral bias susceptibility. In addition to these, we also consider each participant's attitude toward risk.

H1: The high degree of formal financial education will mitigate the impact of individual characteristics on the disposition to behavioral biases.

We proceed to H2 to examine how financial literacy affects each behavioral bias. In this section, we will investigate the role that financial literacy plays in influencing the presence or not of the behavioral biases that are on focus of this research. Since, as already mentioned in the literature, this relationship could be positive or negative depending on the biases in analysis. As a result, we define H2 as non-directional. For that matter, we check if the expected

high level of financial literacy among the individuals with a formal financial education impacts the disposition to loss aversion, gambler's fallacy, ostrich effect, overconfidence, and disposition effect.

H2: The expected high level of financial literacy will influence the presence of each behavioral bias.

The final hypothesis is derived from the work of Kudryavtsev et al., 2012. Hypothesis H3 will explore the existence of cross correlation between the bias. We want to check if someone who is impacted by one of the behavioral biases is more prone to be affected by the other. According with the mentioned study, the correlation between behavioral biases should be positive and strong.

H3: There is a positive correlation between behavioral biases.

4. DATA AND METHODOLOGY

4.1. Data

The data is obtained from an online survey that was available from June 6th to July 30th 2022, having as average response time eight minutes. The survey was shared between students and alumni from different Portuguese universities.

The survey begins with an assessment of the participants' education. The opening question inquires whether the participant has or is pursuing a master's degree in finance or in any other subject related to finance. If no affirmative responses are provided, the questionnaire will be terminated. By doing that we assure that our sample will have the required formal education in finance essential to the study.

Subsequently, there is a collection of socioeconomic and demographic data, including questions about age, gender, and data about the household, as well as the financial products that each participant owns. The questions are adapted from the Online Investor Survey (CMVM, 2018). As a result, a relationship between each person's main characteristics and the survey answers can be evaluated.

The survey proceeds with an overall financial literacy self-evaluation. The question is graded on a scale of 1 to 7 according to Lusardi and Tufano (2015). This question comes before the formal assessment of the individual's financial literacy in order to avoid a self-assessed rating influenced by the answers given under assessment. By quantifying how much each person believes to know, confidence can be measured. Comparing this self-judgment score with the real knowledge that will be measured by correct answers throughout the questionnaire, we can have a good look at individuals´ overconfidence. Following the previously mentioned Online Investor Survey (CMVM, 2018), participants are also asked to self-assess their knowledge in comparison to the Portuguese population. We also consider the self-evaluated willingness to take risks. This question is graded from 1 to 5, with 5 indicating a very risk lover attitude.

When it comes to measuring financial literacy, this research will assess basic financial literacy as well as more advanced financial knowledge. All the questions will be based on Van Rooij et al. (2007) meeting four criteria: simplicity, relevancy, conciseness, and differentiation (Lusardi & Mitchell, 2014).

The first group will seek to assess knowledge of daily financial transactions and the fundamentals of financial planning. By doing that, the first five questions will analyze the numeracy, the understanding of how compound interest rates work as well as inflation, the time value of money, and if the participants suffer from money illusion.

The advanced set of questions measures financial literacy more related to investment, financial asset portfolio management, and risk assessment. These 11 questions will require an in-depth understanding of finance.

To measure the presence of each behavioral bias to which a person is prone, a set of questions was built considering the relevant literature.

Regarding loss aversion, two questions are formulated intending to identify the presence of this bias, following Kahneman and Tversky (1979) paper. Depending on how each investor addresses these two problems we can evaluate the fear of losses. The first question measures risk aversion by looking at a guaranteed gain compared to an even bigger profit but associated with a certain risk. At the same time, the following question assesses the aversion to losses by proposing a similar problem but with a guaranteed loss. An individual will be considered loss averse if answering options a) and b) on these two questions, respectively.

To determine the presence of gambler's fallacy we followed the study of Tversky and Kahneman (1971). The first issue deals with a coin toss. Although the probability of head or tail will be the same in all games, after long series of the same output, people forget this fact. The other question follows the same logic however it proves that gambler's fallacy is not exclusively for gamblers.

The disposition effect questions were based on Shefrin and Statman's (1985) paper. The first question examines the tendency to sell profitable assets too soon and enjoy the rewards right away. Simultaneously, there is also a question that assess the predisposition to keep losers too long and thus postpone a possible heavier loss.

The final question intends to know the frequency with which each investor checks their portfolios when the markets are falling vs when they are rising to deduce the existence of ostrich effect bias. Indeed, by answering this question, you can measure how each individual reacts to both good and unpleasant news. This question was set up in accordance with Karlson et al (2009).

There were 158 responses to the survey. Twelve of them, however, were immediately removed because the corresponding participant does not have or is enrolled in a master's degree in finance or related topics. Nonetheless, 55 entries were disregarded in order to obtain more accurate results. This occurred because these participants only answered demographic questions, which added no value to our research. Therefore, were considered 91 answers, 67 (73,63%) registered by individuals still attending a master's degree in finance or related topics, and 24 (26,37%) by participants with a master's degree in these academic subjects completed.

Over seventy-eight percent (78,02%) of the participants are young adults under the age of thirty. Our overall sample has a gender distribution that is fairly typical, with 38,46% of females and 61,54% of men. The majority of participants (40,66%) have a four-person family and earn between 1001€ and 2500€ per month (37,36%). We can also admit that our sample has some knowledge of financial products, as 72.53% of our sample owns at least one. The most mentioned are demand and savings deposits, credit cards, insurance, and stocks.

In terms of self-assessed financial knowledge, 46.16% of those polled gave themselves a score of 6 or 7, the highest possible. The average score is 5.22 out of 7. This score rises to 5,96 when they were asked to compare their knowledge with to their perception of the Portuguese population's level of financial literacy. According to the extensive literature on the

subject, females rated themselves much lower than men. Only two of the thirteen people who gave themselves the highest possible score were women.

We can also classify our sample as risk averse because more than 80% rate their risk attitude as 3 or lower on a scale of 1 (extremely risk averse) to 5 (very risk lover). We also observe a gender effect on risk attitude, with only one woman among the 17 people who described themselves with a score of 4 or 5.

Regarding the evaluation of financial literacy among participants, our findings revealed a mean of 13,03 points out of 16. It is worth noting that 29,67% of our participants received the maximum score, with 22 males outnumbering 5 females. Another interesting point is that the proportion of correct questions within the most advanced questions is slightly higher. Indeed, the average percentage of correct answers is 87,47%. When compared to the slot of the more basic questions, this value decreases to only 87,25%.

When considering the five behavioral biases, we can conclude that 92,59% of the participants do not experience loss aversion. Furthermore, the presence of the gambler's effect is unequivocal (88,75%), but there is no significant gender disparity. In terms of the disposition effect, we examined it in two ways. In terms of losses, 64,56% of people keep a losing investment for too long. In terms of winners, 56,96% of our sample sell profitable investments too early. Furthermore, women are slightly more prone to this bias.

The presence of the ostrich effect is barely visible. This bias affects only 11,39% of the population. However, eight of the nine participants exhibiting this are men.

4.2. Methodology

To quantify financial literacy, we will use the outcomes of the questionnaire to build four different financial literacy measures.

For the main measure, we will consider the total points earned in the financial literacy set of questions – *ObjectiveFLI*. The questions will be equally scored, each correct answer adds one point to the final score. The maximum score for basic questions will be 5 and, for the more advanced questions, it will be 11, in a total of 16 points. *ObjectiveFLI* will be the percentage of correct answers.

The next measures will be created to provide extra robustness. In the first one – *AverageFLI* – we will compare the actual knowledge (the total score obtained) with the average

score of the sample. Therefore, we create a dummy variable that assumes a value of 0 if the level of financial literacy is below average or 1 if this value is above average.

Additionally, we will create an index that relies on dimensionality-reduction based on Van Rooj et al. (2011) – *AggregateFLI*. The Principal Component Analysis (PCA) is a dimensionality-reduction method that transforms a large set of variables into a smaller one while retaining as much information as possible. By doing this, we create a new variable that combines all 16 questions into one component. As so, at a trade of a little accuracy we have a simpler and unique variable.

Lastly, the measure of self-evaluated level of financial literacy (*SubjectiveFLI*) will assume a value between 1 and 5, being 1 a very low level and 7 a very high. A level of 4 is considered as average.

Considering the answers to the questions, each behavioral bias under the scope of our study will be coded to a dummy variable, that will assume a value of 1 if the bias is present or 0 otherwise. Regarding overconfidence, we will compare the self-evaluated level of knowledge with the actual knowledge. Therefore, we will compare *SubjectiveFLI* with *AverageFLI*. If the participant evaluated himself with more than 4 points (above average), he is considered overconfidence if his score of *AverageFLI* is 0 (below average).

Regarding demographic variables, the participant's age (*Age*) can assume any number and the gender (*Gender*) will assume the value 1 if the participant is woman and 0 otherwise.

We will also analyze two more variables regarding the household: the number of members (*Household*) and the level of income (*Income*). *Income* can range between 1 and 4, where 1 reflects an income between 501€ and 1000€ / month, 2 between 1001€ and 2500€ / month, 3 between 2501€ and 4000€ / month and 4 symbolizes a household income of more than 4000€ / month. The value of the *Household* will range from 1 to 5. The scale goes from 1 denoting a household with only one member, until 5, that will reflect a household with five or more members.

The dummy variable *Experience* will assume the value of 1 if an individual owns financial products and 0 otherwise. Additionally, if a participant has a master's degree in finance or in a similar field, the *Education* variable will have a value of 1, and if the participant has not finished the master yet but is attending one, it will assume a value of 0.

The risk attitude will be measured from 1 to 5. The scale goes from 1 if the level of risk that a person is willing to take is very low until 5, if the participant is very risk lover.

5. THE MODEL

Following the discussion of the relevant variables in the previous chapter, we will conduct further analysis to test the hypotheses that are the subject of the study analysis using the model shown below:

$$(1)\ Behavioral\ Biases = \alpha + \beta_1\ Gender + \beta_2\ Age + \beta_3\ Income + \beta_4\ Household + \beta_5\ RiskAttitude + \beta_6\ FinancialLiteracy + e$$

The behavioral biases present in the investment decisions, the personal characteristics of the individuals and the level of financial knowledge are three dimensions that are connected. We compute a correlation matrix to get an idea of how strong this connection is.

In addition, since our dependent variables are binary, assuming a value of 1 if the bias is present and 0 otherwise, we will use a Binary Logistic Regression. There must be little to no multicollinearity among the independent variables for using this type of regression.

The correlation matrix can be observed in Appendix 3. We compute two different types of correlation matrices given that some of the variables—like *Age, RiskAttitude,* or *Income*—are continuous while others are binary, like each behavioral bias. We use the Tetrachoric Correlation for binary variables and the Pearson Correlation for continuous data.

We can see that there is little correlation between the independent variables since the correlation coefficients are less than 0,5. When we take a look at the set of dependent variables, we can see that the correlation coefficient between loss aversion and gambler's effect is 1. The two variables have a positive and strong correlation and will move in the same direction. Therefore, a high likelihood of experiencing loss aversion implies a higher likelihood of suffering from gambler's fallacy. We will go into greater detail about the possible relationship between biases when analyzing our third hypothesis

In addition to the correlation matrix, we compute another measure of the presence of multicollinearity. The variance inflation factor (VIF) quantifies the severity of multicollinearity having as a rule of thumb that if VIF exceeds 10 there are signs of serious multicollinearity.

The results in Table 1 assume *LossAversion* as the dependent variable, however, VIF was calculated for each behavioral bias. We can observe that for *LossAversion* there is no visible presence of multicollinearity in our model, with the mean equaling 1,212. The result is the same when performing the analysis using the remaining dependent variables. The VIF of each variable doesn't represent an issue.

Table 1 - Variance Inflation Factor performed with Loss Aversion as the dependent variable

Variables	VIF	1/VIF
Income	1.338	0.748
ObjectiveFLI	1.314	0.761
Education	1.214	0.824
Household	1.194	0.837
Age	1.187	0.843
Experience	1.142	0.876
Gender	1.095	0.913
Mean VIF	1.212	

6. RESULTS

Our first hypothesis seeks to determine whether the required formal education in finance can mitigate the impact of the demographic variables (*Age, Gender, Income, and Household*) and *RiskAtittude* in the presence of behavioral biases. According to the previously mentioned literature, there are reasons to believe that individuals' characteristics affect whether behavioral biases are present or not. Nevertheless, in this study, we try to prove quite the inverse: when the sample has a formal financial education, this imbalance will be mitigated.

In addition, to respond to our second hypothesis we are interested in examining the connection between behavioral biases and financial literacy. As supported by the literature, a higher level of financial literacy could mitigate or enhance the presence of behavioral biases. To comprehend how they affect behavioral biases when the degree of financial literacy is considered, the factors that control personal characteristics are maintained.

We perform a bivariate analysis of the mean proportion to be able to establish an empirical relation between the behavioral bias of the participants with their personal characteristics, including the level of financial literacy. We perform a T-Test when analyzing binary variables, like *Gender*, and a Anova test when the variable under analysis has more than two groups, like *Income* or *RiskAttitude.*

Based on the results in Appendix 3, we can state that *Income* is statistically significant (at a level of 5%) in predicting the presence of *DispositionEffectLosses*. Individuals with a higher income will be the ones more prone to hold a losing investment for too long, which is not in accordance with the literature (Dahn & Zhu, 2002; Weber & Welfens,2008). An

individual that belongs to a household with an income of more than 4000€/month, will increase their chances of holding a losing investment for a long period of time by 0,765. Moreover, *RiskAttitude* is statistically significant (at a level of 10%) in explaining *GamblerFallacy.*

Despite not being statistically significant, some patterns are still important to note. Lower-income bands show higher levels of loss aversion, as well as higher levels of overconfidence. Surprisingly, females appear to be more confident. Overconfidence is also more visible in participants that already finished their studies. In accordance with Sicherman et al. (2012), men seem to be more susceptible to the ostrich effect. Women have slightly more chances to experience disposition effect. As so, females are more hesitant to incur a loss with hopes of recovery, while tend to sell profitable assets right away to ensure a profit which is consistent with the previous literature (Frino et all, 2015). We can also see that the more risk-averse individuals, that self-rated themselves with a score of 1, are in fact the most prone to loss aversion. This is quite expected considering that a loss has a stronger emotional effect than an equivalent gain for a person that experiences loss aversion (Tversky and Kahneman, 1979). Loss aversion bias is more present in inexperienced investors, the ones that don´t have any financial products, which is not in accordance with Bokhari & Geltner (2011). Moreover, a higher number of household members reflects a higher proneness to incur in ostrich effect. Regarding education, participants enrolled in a master's degree showed less gambler's effect, disposition effect, and overconfidence.

Regarding H2, we can state that *ObjectiveFLI* is statistically significant at a level of 1% in predicting *Overconfidence*. This impact is positive which means that the proneness to overconfidence is enhanced by a higher level of financial literacy. Hence, having a higher level of financial literacy can make someone more susceptible to suffering from *Overconfidence*, which is in accordance with Bhandari and Deaves (2006).

In addition, we can observe that *SubjectiveFLI*, one of the alternative measures of financial literacy that measures the self-evaluated grade of financial knowledge, is statistically significant in predicting *LossAversion* at a level of 5% and *Overconfidence* at a level of 10%. Both coefficients are positive, which means that a higher score of *SubjectiveFLI* will enhance the predisposition of both loss aversion and overconfidence. This result is quite expected when talking about overconfidence but not so much regarding loss aversion. According to Johnson et al. (2006), more knowledge will result in a greater tendency to loss aversion behavior.

Although not statistically significant, it was also interesting to observe that participants who gave themselves the highest possible grade in the self-evaluation question also tended to

be more susceptible to the ostrich effect. Additionally, they are least likely to fall victim to the gambler's fallacy, disposition effect, and loss aversion.

To test our two first hypotheses – H1 and H2 - we ran a Binary Logit Regression model since our dependent variables are binary, assuming the value of 1 if there is a presence of the bias or 0 otherwise.

As shown in the results in Table 2, *Income* is statistically significant at a level of 5% in predicting the presence of *DispositionEffectLosses*. A higher income will increase by 0,680 units the proneness to disposition effect concerning losses. This is not following the past findings mentioned in the literature. One explanation could be that if a household has more disposable income, it will be less concerned if it loses money, as it will be able to hold a losing investment for a longer time to see whether it can catch up. Moreover, *Household* is positively statistically significant at a level of 10% in predicting the presence of *OstrichEffect* and *Overconfidence*. Therefore, a higher number of members in the household will increase the probability by 0,725 to suffer from ostrich effect. The opposite is true for *Overconfidence*. A high number of members will decrease the odds by 0,491 from experience overconfidence. These results are coherent with the prior bivariate analysis of the mean.

We are unable to fully validate our first hypothesis. The level of income can indeed impact the proneness to suffer from the disposition effect in terms of losses. Moreover, the number of members in the household also seems to influence the disposition to ostrich effect and overconfidence behavior. However, it appears reasonable to affirm that, when securing a formal education in finance, the impact of demographic data on the predisposition to any other behavioral biases on investment decisions can be mitigated. More specifically, we can conclude that, when formal financial education is present, gender, age, and attitude toward risk do not influence the presence of behavioral biases.

Regarding H2, *ObjectiveFLI* is statistically significant at a level of 1% in predicting *Overconfidence*. *ObjectiveFLI* has a negative impact on each bias, which means that the proneness to overconfidence can be minimized if assuring a high financial literacy, which is in accordance with Ates et al. (2016) and Rassol and Ullah (2019). This result contradicts the one obtained from the bivariate analysis. This indicates that the marginal impact of every variable at the same time leads to differences in terms of pairwise association.

We are unable to verify the full validity of our second research hypothesis. Although a high actual financial literacy level mitigates the predisposition to overconfidence, the level of financial knowledge does not affect the disposition for the remaining behavioral biases.

Table 2 - Binary Logit Regression for each Behavioral Bias considering ObjectiveFLI

Binary Logit Regression						
	LossAversion	***GamblerFallacy***	***DispositionEffectLosses***	***DispositionEffectGains***	***OstrichEffect***	***Overconfidence***
Variables	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)
Gender	-0,774 (1,253)	-0,499 (0,998)	0,074 (0,642)	-0,059 (0,594)	-1,364 (1,199)	-0,800 (0,898)
Age	-0,019 (0,064)	0,036 (0,064)	0,006 (0,030)	0,017 (0,028)	-0,027 (0,047)	-0,033 (0,047)
Income	-0,722 (0,478)	0,207 (0,395)	0,680** (0,285)	-0,190 (0,251)	0,066 (0,399)	-0,392 (0,338)
Household	-0,119 (0,370)	0,131 (0,304)	-0,164 (0,210)	-0,044 (0,197)	0,725* (0,411)	-0,491* (0,296)
RiskAttitude	-0,693 (0,594)	-0,435 (0,416)	-0,073 (0,289)	-0,185 (0,269)	0,246 (0,394)	-0,480 (0,436)
ObjectiveFLI	1,375 (3,275)	-0,974 (2,92)	-0,212 (1,743)	-0,952 (1,830)	0,679 (3,607)	-4,897*** (1,334)
Constant α	1,498 (5,114)	2,301 (4,046)	-1,031 (2,350)	1,989 (2,285)	-5,126* (4,111)	7,590** (3,416)

****Significant at 1% level; ** Significant at 5% level; *Significant at 10% level*

Therefore, we cannot fully validate our second hypothesis when discussing our primary measure of financial literacy. The level of financial knowledge will impact overconfidence.

Contrary to our expectations, the level of financial literacy has no impact on the global predisposition for behavioral biases. Considering our sample, this outcome is quite predictable. The participants of our survey have a master's degree in finance or equivalent, which means that they have a much more comparable level of knowledge of finance matters. As a result, when considering a sample with a similar level of knowledge, establishing any association between knowledge level and any behavioral bias remains tough.

In order to provide extra robustness, we will now run the regressions for three alternative financial literacy measures – *SubjectiveFLI*, *AverageFLI*, and *AggregateFLI* - discussed in the methodology chapter to strengthen the validity of our findings.

We start by replacing *ObjectiveFLI*, our principal measure of financial literacy, with *SubjectiveFLI*. *SubjectiveFLI* is the self-evaluated level of financial literacy from each participant, ranging from one to seven. The results are reported in table 3.

Regarding H1, we can observe that Income is statistically significant in predicting each *DispositionEffectLosses* at a 1% level. The coefficient regarding *DispositionEffectLosses* is

negative, which indicates that a higher income will increase by 0,717 the probability to hold a losing investment for too long. A similar result to the one obtained when using our main measure of financial literacy. Furthermore, *Income* is also statistically significant in predicting *Overconfidence* at a level of 5%. A high income will decrease the odds by 0,812 of incurring in overconfident behavior. Moreover, *Gender* will be statistically significant at a level of 10% in predicting *Overconfidence*. Contrary to the literature, being a woman will increase by 1,416 the proneness to overconfidence. The *Household* will also be statistically significant in predicting *OstrichEffect* at a level of 5%, a larger household will increase by 0,898 the predisposition to ostrich effect.

When using this alternative measure to quantify financial literacy, the results are less in accordance with our expectations than when using our main metric. As so, we cannot validate our hypothesis that higher formal education in finance can mitigate the impact of personal aspects in the proneness to behavioral biases. The gender of the participant and the income and the number of members of the household will impact the predisposition to disposition effect in terms of losses, ostrich effect, and overconfidence. Only age tends to have no impact on the probability to occur in a behavioral bias in the investment decision-making process.

Table 3 - Binary Logit Regression for each Behavioral Bias considering SubjectiveFLI

	Binary Logit Regression					
	LossAversion	***GamblerFallacy***	***DispositionEffectLosses***	***DispositionEffectGains***	***OstrichEffect***	***Overconfidence***
Variables	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)
Gender	-0,882 (1,286)	-1,280 (1,130)	-0,107 (0,699)	0,318 (0,654)	-0,738 (1,180)	1,416* (0,814)
Age	-0,034 (0,058)	0,028 (0,065)	0,005 (0,029)	0,023 (0,028)	-0,030 (0,047)	0,019 (0,035)
Income	-0,679 (0,486)	0,320 (0,411)	0,717*** (0,279)	-0,311 (0,249)	-0,089 (0,421)	-0,817** (0,322)
Household	-0,125 (0,435)	-0,073 (0,324)	-0,223 (0,229)	0,055 (0,215)	0,898** (0,439)	-0,064 (0,253)
RiskAttitude	-0,751 (0,599)	-0,573 (0,440)	-0,096 (0,291)	-0,146 (0,274)	0,310 (0,427)	-0,085 (0,356)
SubjectiveFLI	0,032 (0,462)	-0,694* (0,402)	-0,162 (0,245)	0,252 (0,235)	0,568 (0,387	0,659** 0,312
Constant α	2,997 (4,679)	6,407 (4,205)	-0,151 (2,382)	-0,467 (2,242)	-7,961** (3,837)	-2,883 (3,917)

****Significant at 1% level; ** Significant at 5% level; *Significant at 10% level*

Regarding H2, *SubjectiveFLI* will be statistically significant in predicting *Overconfidence* at a 5% level. The impact is positive, which means that overconfidence is more likely to occur when a higher self-evaluated financial literacy level is assumed. Since *Overconfidence* was developed by comparing the actual knowledge with the grade that each respondent ended up giving themselves, this was already anticipated. As a result, the likelihood of developing overconfidence increases by 0,659 the more a person believes they know.

Moreover, *SubjectiveFLI* will also be statistically significant in predicting *GamblerFallacy* at a 10% level. In this case, the coefficient is negative (-0,694). As so, the relationship between the self-evaluated level of financial literacy and the gambler's fallacy bias will be inverse. The highest the grade, the lower will be the odds of incurring in gambler's fallacy.

We can validate our second hypothesis when analyzing *GamblerFallacy* and *Overconfidence* as dependent variables. For the remaining bias, no relationship between them and *SubjectiveFLI* was found.

Subsequently, we will test our model for another two measures of financial literacy – *AggregateFLI* and *AverageFLI*. *AverageFLI* assumes the value of 1 if the participant has an above-average level of financial literacy and 0 otherwise.

The results are reported in Table 4. The overconfidence variable was not included in the regression using *AverageFLI*, since these two variables are correlated. Given how the Overconfidence variable was created (detailed in the methodology chapter), performing a regression was impossible because the variable *AverageFLI* predicts failure exactly and was consequently dropped.

As we can observe, *Income* remains statistically significant in predicting *DispositionEffectLosses*, in this case at a level of 1%. Each increase in the income scale (from 1 to 5) will increase 0,747 the probability of experiencing a disposition effect regarding losses.

Household is statistically significant in predicting the *OstrichEffect* at a level of 10%. This relationship is positive. An individual that is part of a large household will have 0,718 more probability of experiencing the ostrich effect.

Gender, Age, and Risk Attitude aren't associated with the predisposition to behavioral biases in investment decision-making.

As so, we reject our first hypothesis when considering *DispositionEffectLosses* and *OstrichEffect* as the dependent variable. However, we can validate the hypothesis for any other

bias since none of the personal characteristics seem to influence the predisposition to them when formal financial education is ensured. The outcomes produced by *AverageFLI* are consistent with the earlier results.

Regarding H2, we can state that *AverageFLI* doesn´t seem to have any statistically significant impact on any behavioral bias. Even when employing an alternative measurement of actual financial literacy, we continue to reject this hypothesis since we observed no association between financial literacy and behavioral biases.

Table 4 - Binary Logit Regression for each Behavioral Bias considering AverageFLI

Binary Logit Regression					
	LossAversion	***GamblerFallacy***	***DispositionEffectLosses***	***DispositionEffectGains***	***OstrichEffect***
Variables	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)
Gender	-0,557 (1,278)	-0,768 (1,026)	-0,052 (0,652)	-0,072 (0,595)	-1,287 (1,199)
Age	-0,009 (0,057)	0,031 (0,062)	0,003 (0,029)	0,019 (0,028)	-0,027 (0,046)
Income	-0,773 (0,486)	0,300 (0,397)	0,747*** (0,285)	-0,195 (0,246)	0,048 (0,392)
Household	-0,104 (0,374)	0,116 (0,305)	-0,177 (0,211)	-0,041 (0,198)	0,718* (0,410)
RiskAttitude	-0,670 (0,587)	-0,437 (0,415)	-0,067 (0,290)	-0,178 (0,270)	0,230 (0,392)
AverageFLI	1,222 (1,297)	-1,339 (1,185)	-0,580 (0,621)	-0,348 (0,579)	0,621 (1,169)
Constant α	1,468 (3,468)	2,485* (2,960)	-0,865 (1,800)	1,352 (1,673)	-4,920* (2,851)

****Significant at 1% level; ** Significant at 5% level; *Significant at 10% level*

Until now, we have tested our hypothesis using three different financial literacy measures: *ObjectiveFLI*, *SubjectiveFLI*, and *AverageFLI*. Now we'll look at *AggregateFLI*. This variable is an index that was created to join the sixteen financial literacy questions in the survey. A complete explanation of its construction can be found in the methodology chapter.

Table 5 shows the results obtained. *Income* and *Household* are still statistically significant in predicting *DispositionEffectLosses* (at a 5% level) and *OstrichEffect* (at a 10% level). The outcomes are comparable to those that were previously shown. An increase in available money increases the likelihood of retaining a lost investment for too long by 0.893, while being part of a large family increases the probability of experiencing the ostrich effect

by 0.865. *Income* is statistically significant in predicting *Overconfidence* at a 5% level. Income will harm the likelihood of that bias, which is not in accordance with Isidore and Christie (2018). Indeed, having more money will decrease the odds by 0,620 of incurring in an overconfident behavior.

We must refute our initial hypothesis since *DispositionEffectLosses, OstrichEffect* and *Overconfidence* seem to be influenced by personal aspects when considering *AggegateFLI* as the measure of financial literacy. For any other dependent variable, we can validate our hypothesis.

Table 5 - Binary Logit Regression for each Behavioral Bias considering AggregateFLI

Binary Logit Regression						
	LossAversion	***GamblerFallacy***	***DispositionEffectLosses***	***DispositionEffectGains***	***OstrichEffect***	***Overconfidence***
Variables	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)
Gender	-1,007 (1,183)	-0,274 (0,954)	-0,028 (0,672)	-0,087 (0,621)	-1,666 (1,204)	0,664 (0,710)
Age	-0,053 (0,063)	0,064 (0,070)	0,007 (0,031)	0,028 (0,030)	-0,037 (0,048)	-0,003 (0,037)
Income	-0,650 (0,459)	0,132 (0,398)	0,893** (0,316)	-0,414 (0,268)	-0,199 (0,411)	-0,620** (0,304)
Household	-0,212 (0,402)	0,218 (0,345)	-0,210 (0,232)	-0,024 (0,218)	0,865* (0,455)	-0,306 (0,246)
RiskAttitude	-0,759 (0,621)	-0,494 (0,430)	-0,352 (0,319)	-0,265 (0,301)	0,245 (0,428)	-0,034 (0,350)
AggregateFLI	-0,376 (0,427)	0,398 (0,356)	0,015 (0,283)	0,484* (0,284)	-0,040 (0,402)	-0,369 (0,267)
Constant α	3,972 (3,658)	0,680 (3,140)	-1,140 (1,856)	1,726 (1,817)	-3,641 (2,815)	1,579 (2,218)

****Significant at 1% level; ** Significant at 5% level; *Significant at 10% level*

Regarding H2, *AggregateFLI* is statistically significant in predicting *DispositionEffectGains*. The association is positive, which means that a high level of knowledge will increase the probability to sell profitable assets too early. This is in accordance with Vaarmets et al (2019), which found that education in finance can enhance the predisposition for this bias.

We can state that financial knowledge has indeed a positive impact on the disposition effect in terms of gains, so we can validate our second hypothesis when considering

DispositionEffectGains as our dependent variable. However, we reject our hypothesis for any other since the level of financial literacy seems to have no impact on the remaining.

In our last hypothesis (H3), we aim to determine if there is a correlation between behavioral biases when our sample has formal education in finance. According to Kudryavtsev et al. (2012), it is expected that an investor behaves consistently, more "rationally" or more "intuitive". Therefore, the behavioral biases should be positively correlated indicating that if an individual is affected by one of these biases, they will also be more prone to be affected by others.

The correlation coefficients between the behavioral biases are shown in Appendix 3. The conclusions are mixed. The correlation coefficient between *GamblerFallacy* and *LossAversion* is 1. This value indicates an extremely strong correlation between these two variables. We can indeed state that if a person suffers from loss aversion, they will suffer from gambler's fallacy. Nevertheless, the conclusions are mixed. We can admit that there are behavioral biases positively correlated with each other. For illustration, the correlation coefficient between *Overconfidence* and *DispositionEffectLosses* has a correlation coefficient of 0,2696. However, the relationships are deemed to be weak. On the opposite side, there are several negatively correlated variables. For example, *GamblerFallacy* with *OstrichEffect* or *DispositionEffect*Gains with *LossAversion*. Although, there are no negative strong relationships.

We are unable to validate our hypothesis since the results are ambiguous. Therefore, we were unable to find sufficient evidence to demonstrate that people consistently act in a rational or intuitive manner. Besides that, we can indeed conclude that if an individual is prone to loss aversion, he will be more prone to gambler's fallacy.

For our additional analysis, we go further to understand the role of education and the role of experience in the relationship between personal aspects, behavioral biases, and the level of financial literacy. We will add two new variables to our initial model that proxy either education and experience to have a look at the changes, if any, in the results obtained so far.

Firstly, we introduce *Education* into the model. *Education* is a dummy variable that will assume a value of 1 if the participant has completed a master's degree in finance or in topics related or 0 if the individual is enrolled in a master's degree with the same characteristics, but did not finish it yet. With that, we want to understand if having a master's degree concluded,

and, as consequence, being more financially educated, plays a critical role in predicting behavioral biases in investment decision-making.

We run the regression using our main measure of financial literacy – *ObjectiveFLI.* The results can be observed in table 6. *Income* is statistically significant in predicting *DispositionEffectLosses* at a level of 5% and in predicting *Overconfidence* at a level of 5%. As so, the more income available a participant has, the probability of holding a losing investment too long increases by 0,639, and the odds of being overconfident decrease by 0,499.

Table 6 - Binary Logit Regression for each Behavioral Bias using ObjectiveFLI considering Education

Binary Logit Regression						
	LossAversion	***GamblerFallacy***	***DispositionEffectLosses***	***DispositionEffectGains***	***OstrichEffect***	***Overconfidence***
Variables	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)
Gender	-0,702 (1,270)	-0,557 (0,993)	0,014 (0,646)	-0,055 (0,595)	-1,397 (1,216)	-1,109 (0,968)
Age	-0,018 (0,063)	0,030 (0,063)	0,002 (0,031)	0,018 (0,029)	-0,031 (0,052)	-0,055 (0,055)
Income	-0,699 (0,490)	0,162 (0,409)	0,639** (0,290)	-0,180 (0,259)	0,035 (0,424)	-0,499** (0,352)
Household	-0,137 (0,377)	0,182 (0,319)	-0,121 (0,218)	-0,054 (0,207)	0,756* (0,441)	-0,409 (0,305)
RiskAttitude	-0,666 (0,601)	-0,475 (0,425)	-0,108 (0,295)	-0,177 (0,273)	0,225 (0,406)	-0,556 (0,449)
Education	-0,362 (1,243)	0,503 (0,945)	0,454 (0,622)	-0,093 (0,568)	0,228 (1,098)	1,180 (0,749)
ObjectiveFLI	1,143 (3,235)	-0,749 (2,806)	0,025 (1,775)	-1,004 (1,865)	0,759 (3,669)	-5,268*** (1,421)
Constant α	1,641 (4,999)	2,286 (3,921)	-1,138 (2,370)	2,007 (2,294)	-5,081** (4,157)	8,499** (3,729)

****Significant at 1% level; ** Significant at 5% level; *Significant at 10% level*

Household is statistically significant in predicting *OstrichEffect* at a 10% level. A larger household will increase the chances of investors ignoring risky investments and bad news will increase by 0,756.

Regarding H2, the results remain the same even when considering *Education*. *ObjectiveFLI* is statistically significant in predicting *Overconfidence* at a level of 1%. This relationship is negative as was before. The more financially literate an individual is, the lower the probability to be overconfident. Education doesn't have a statistically significant impact on the predisposition to any behavioral bias. As so, having a master's degree in finance or being enrolled in one, doesn't influence the outcomes of our initial analysis.

Finally, we want to understand the impact of being considered experienced or not on financial products on our results. *Experience* is a dummy variable that assumes the value of 1 if the investor owns financial products and 0 otherwise. We will characterize an investor that owns financial products as experienced and not experienced, otherwise. The results are summarized in table 7.

Table 7 - Binary Logit Regression for each Behavioral Bias using ObjectiveFLI considering Experience

Binary Logit Regression						
	LossAversion	***GamblerFallacy***	***DispositionEffectLosses***	***DispositionEffectGains***	***OstrichEffect***	***Overconfidence***
Variables	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)	Estimate (Std.Error)
Gender	-0,760 (1,270)	-0,575 (1,016)	0,078 (0,644)	-0,096 (0,600)	-1,329 (1,205)	-0,827 (0,904)
Age	-0,027 (0,068)	0,047 (0,068)	0,006 (0,031)	0,021 (0,029)	-0,031 (0,048)	-0,030 (0,047)
Income	-0,730 (0,473)	0,231 (0,395)	0,679** (0,286)	-0,177 (0,252)	0,040 (0,402)	-0,362 (0,344)
Household	-0,116 (0,384)	0,129 (0,310)	-0,162 (0,211)	-0,055 (0,200)	0,743* (0,420)	-0,504* (0,296)
RiskAttitude	-0,720 (0,600)	-0,400 (0,414)	-0,076 (0,290)	-0,169 (0,272)	0,218 (0,399)	-0,468 (0,439)
Experience	-0,612 (0,979)	0,572 (0,838)	-0,211 (0,590)	0,313 (0,557)	-0,353 (0,865)	0,356 (0,740)
ObjectiveFLI	1,367 (3,445)	-1,103 (3,013)	-0,211 (1,743)	-0,995 (1,857)	0,620 (3,625)	-5,030*** (1,380)
Constant α	2,240 (5,521)	1,58 (4,277)	-0,976 (2,436)	1,655 (2,383)	-4,632 (4,253)	7,264** (3,468)

****Significant at 1% level; ** Significant at 5% level; *Significant at 10% level*

Income is statistically significant in predicting *DispositionEffectLosses* at a level of 5%. The higher the income available, the higher will be the proneness of holding a losing asset for too long. This is an outcome already mentioned several times. Also, the household is statistically significant in predicting *OstrichEffect* and *Overconfidence* at a 10% level. An investor from a large home is more likely to avoid unpleasant news, yet at the same time, the same person is less likely to feel that he knows more than he does.

Concerning *Objective FLI*, the results remain the same. *ObjectiveFLI* is still negative and statistically significant in predicting overconfidence bias.

Experience doesn't impact any behavioral biases. We may thus reach the conclusion that having expertise with financial goods has no impact on our sample's propensity for behavioral biases.

We also perform both the regression, for Education and Experience, using the three additional variables responsible for measuring the financial literacy level as we did before. The results including Education or Experience are similar no matter what measure we choose and can be observed at appendices

Income is always positive and statistically significant in predicting *DispositionEffectLosses*, but at different levels of confidence. Moreover, *Income* is statistically significant in predicting *Overconfidence*. *Household* is statistically significant in predicting the *OstrichEffect*, at different confidence levels. *SubjectiveFLI* is statistically significant in predicting *Overconfidence* at a 5% level, an outcome already seen before.

When considering *Education* in the analysis, we can see that *Household* becomes statistically significant at a level of 5% in predicting *GamblerFallacy*. The likelihood of suffering from Gambler's fallacy increases with the size of the participant's family.

The findings achieved while using either Education or Experience are comparable to those reported in our primary results. As a result, these two additional variables appear to not affect our model.

7. CONCLUSION

This study aimed to analyze the influence between personal aspects, financial literacy, and behavioral biases. The behavioral biases under study in this paper were Loss Aversion, Gambler's Fallacy, Disposition Effect (taking into account both gains and losses), Ostrich Effect, and Overconfidence since they were the key behavioral biases studied in the prior literature.

By guaranteeing a high level of formal financial literacy of the participants, we wanted to understand how the connection between the three spheres of study changed. In the end, we wanted to answer to the question: Can a formal education in finance mitigate the proneness to behavioral biases in investment decision-making? We expected formal education to diminish the importance of personal characteristics in behavioral biases found in prior investigations. We also explored the influence of financial knowledge on the propensity of developing behavioral biases. The likely association between behavioral bias was also explored in order to discover whether an individual tends to behave consistently, more rationally or more emotionally.

To achieve the goal of this research, we created a survey that was only available to participants who have or are enrolled in a master's degree in finance or equivalent. The survey

included questions to evaluate the financial literacy of the participants, questions to determine whether they displayed any behavioral biases, as well as personal and demographic questions.

As a result, we could not prove that formal financial education could totally mitigate the influence of personal aspects on the predisposition to behavioral bias. Indeed, we found a significant relationship between the income of the household and the disposition effect bias when we are talking about losses. As so, an individual that earns more money is more reluctant in realizing losses. One reason could be that someone with more money does not feel the same urgency to stop losing money as someone with less money. The wealthy have the option of waiting for a chance at recovery. Moreover, we also found that a higher number of household members also increases the probability of suffering from ostrich effect. Although, we can conclude that there is not any significant impact of age, gender, and risk attitude on the proneness to suffer from any of the biases under study when formal financial education is ensured.

When we take a look at financial literacy, we found that the actual level of financial literacy only impacts the Overconfidence bias. The level of knowledge seems to not have any impact when considering the remaining behavioral bias on finance graduates. One possible explanation is the one that has already been raised. Our sample has an identical level of financial literacy between them. Therefore, establishing any relationship between the level of knowledge and each behavioral bias remains difficult.

We continue our investigation by employing several additional metrics of financial literacy – *SubjectiveFLI, AverageFLI* and *AggregateFLI*. The results obtained are quite similar.

When performing the regression using *SubjectiveFLI,* we were still unable to demonstrate that formal financial education could completely offset the impact of personal factors on the propensity for behavioral bias. We found that a higher income will enhance the probability to hold a losing investment for too long and lower the probability of having an overconfident behavior. Moreover, an individual belonging to a larger household will be more prone to the ostrich effect. When considering *SubjectiveFLI, Gender* also becomes significant in predicting *Overconfidence.* In our sample case, being a woman increases the predisposition to overconfident behavior. This is in clear contradiction with the past literature. One reason for that could be the formal education in finance required. As women have the same level of financial knowledge as men, the concept that men are more susceptible to overconfidence supported by literature can be mitigated. The results obtained using the dummy variable ,*AverageFLI,* were nearly identical. We also found a relationship between income and the proneness to disposition effect in terms of losses. The number of members of the household is

also related to the ostrich effect. When considering this variable, we infer that financial literacy does not affect the likelihood of incurring any behavioral bias. When performing the regression using the third additional measure of financial literacy, *AggregateFLI*, income continues to be related to *DispositionEffectLosses* and *Overconfidence*. The results about the influence of the level of financial literacy on behavioral biases using *AggregateFLI* brought a new point. Higher financial literacy will increase the odds of selling profitable assets too early.

Despite using four distinct financial literacy indicators, the results show little variation. We can stand out the role of the household characteristics. Although we previously argued that a formal education would mitigate the propensity to behavioral biases, we can now confirm that the characteristics of the household in which we live appear to have a strong effect on the probability of incurring in behavioral bias, which will prevent us from making sound and profitable financial decisions. Lastly, we found out that an individual doesn't tend to behave in a predictable way. Therefore, a person is not always rational or emotionally driven. Except for loss aversion and gambler's fallacy, since these two biases are extremely correlated.

The contribution of this study is to provide evidence about the role of education in investment decisions. Despite the exceptions highlighted throughout the research, we can state that the level of formal financial education mitigates the influence of personal aspects that are critical in predicting behavioral biases and, as a consequence, poor financial decisions. Therefore, a formal financial education leaves a clear path to sound investment decisions.

The main limitation of this study was the lower number of participants. We would recommend obtaining a larger sample to be capable of including individuals with more heterogenous backgrounds, mainly regarding age. Even with formal financial education, the peculiarities of the families have a major impact on predicting behavioral biases in investment decision-making by keeping in mind the strong influence of the household features. As a result, it would be interesting to examine this issue in greater detail, considering more factors that describe each participant's household and home environment.

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APPENDICES

Annex 1 – Variables Construction

Variables	**Survey's question**
Education	Have you completed a master's degree in Finance or any master's with topics related to Finance? 1. Yes, I have a master's degree in Finance or any master's with topics related to Finance. 2. No, I am attending a master's in Finance or any master's with topics related to Finance. 3. No, I don't have or attend a master's in Finance.
Age	Please indicate your age. (Open Response)
Gender	Please indicate your gender. 1. Male 2. Female 3. Non-binary/ third gender
Household	Please indicate the size of your household, including yourself: 1. 1 2. 2 3. 3 4. 4 5. 5 or more
Income	Please indicate the option that most closely matches your household income: 1. Up to 500€ / month 2. Between 501€ and 1000€ / month 3. Between 1001€ and 2500€ / month 4. Between 2501€ and 4000€ / month 5. More than 4000€ / month
Experience	Do you own any kind of financial products? 1. No 2. Yes If yes, please indicate which of the following financial products you currently hold: 1. Demand Deposits 2. Savings Deposits 3. Savings Certificates / Treasury Bills / Treasury Bonds 4. Shares 5. Corporate Bonds 6. Investment Funds 7. Commercial Paper 8. Retirement Saving Plans 9. Credit Card 10. Mortgages and Other Credits 11. Crowdfunding Investments 12. Investments in Bitcoins, ICOs and other Digital Currencies 13. ESG Investing 14. Insurance (life, car or health) 15. Others
SubjectiveFLI	How would you assess your Financial Literacy? Scaled question from 1 (very low) to 7 (very high)
RiskAttitude	How do you rate your risk attitude? Scaled Response from 1 (very risk averse) to 5 (very risk lover)

ObjectiveFLI

Which of the following statements describes the main function of the stock market?

1. The stock market helps to predict stock earnings
2. The stock market results in an increase in the price of stocks
3. The stock market brings people who want to buy stocks together with those who want to sell stocks
4. None of the above

Which of the following statements is correct? If somebody buys the stock of firm B in the stock market:

1. He owns a part of firm B
2. He has lent money to firm B
3. He is liable for firm B's debts
4. None of the above

Which of the following statements is correct?

1. Once one invests in a mutual fund, one cannot withdraw the money in the first year
2. Mutual funds can invest in several assets, for example invest in both stocks and bonds
3. Mutual funds pay a guaranteed rate of return which depends on their past performance
4. None of the above

Which of the following statements is correct? If somebody buys a bond of firm B:

1. He owns a part of firm B
2. He has lent money to firm B
3. He is liable for firm B's debts
4. None of the above

Considering a long time period (for example 10 or 20 years), which asset normally gives the highest return?

1. Savings accounts
2. Bonds
3. Stocks

Normally, which asset displays the highest fluctuations over time?

1. Savings accounts
2. Bonds
3. Stocks

When an investor spreads his money among different assets, does the risk of losing money:

1. Increase
2. Decrease
3. Stay the same

If you buy a 10-year bond, it means you cannot sell it after 5 years without incurring a major penalty. True or false?

1. True
2. False

Stocks are normally riskier than bonds. True or false?

1. True
2. False

Buying a company stock usually provides a safer return than a stock mutual fund. True or false?

1. True
2. False

If the interest rate falls, what should happen to bond prices?

1. Rise
2. Fall
3. Stay the same

LossAversion	In addition to whatever you own, you have been given 1,000€. You are now asked to choose between: 1. get more 1000€ or 0€ given 50-50 odds 2. get more 500€ with 100% certainty Now in addition to whatever you own, you have been given 2,000€. You are now asked to choose between: 1. lose 1000€ or 0€ given 50-50 odds 2. lose 500€ with 100% certainty
GamblerFallacy	Suppose you flip a coin 10 times. If the first 9 flips always come up tails, what is the probability (in %) that it will come up 'tails' on the tenth flip? (Open Response) The mean IQ of the population of eighth graders in a city is known to be 100. You have selected a random sample of 50 children for a study of educational achievements. The first child tested has an IQ of 150. What do you expect the mean IQ to be for the whole sample? 1. 100 2. 101 3. 111 4. 121
DispositionEffectLosses	Suppose that an investor must decide whether to realize a loss or hold a stock for one more period. This investor purchased that stock one month ago for $50 and now finds that it is selling for $40. In addition, let's assume that one of two equiprobable outcomes will emerge during the coming period: either the stock will increase in price by $10 or decrease in price by $10. To simplify the discussion, assume that there are no taxes or transaction costs. 1. Sell the stock now, thereby realising a $10 loss 2. Hold the stock for one more period, given 50-50 odds between losing an additional $10 or "breaking even"
DispositionEffectGains	Now suppose that the same stock is selling at $60. 1. Sell the stock now, thereby realising a $10 profit 2. Hold the stock for one more period, given 50-50 odds between losing an additional $10 or "breaking even"
OstrichEffect	How often do you monitor your investments? 1. When market is going up a) Never b) Sometimes c) About half the time d) Most of the time e) Always f) I don’t have any kind of investment 2. When market is going down : a) Never b) Sometimes c) About half the time d) Most of the time e) Always f) I don’t have any kind of investment

Annex 2 - Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Age	91	27.319	8.842	21	65
Gender	91	.385	.489	0	1
Household	91	3.143	1.207	1	5
Income	91	3.495	1.026	1	5
RiskAttitude	91	2.714	.992	1	5
Education	91	.264	.443	0	1
Experience	91	.725	.449	0	1
ObjectiveFLI	91	.815	.248	.125	1
SubjectiveFLI	91	5.22	1.209	1	7
AverageFLI	91	.659	.477	0	1
AggregateFLI	82	0	1	-1.943	.508
LossAversion	81	.074	.264	0	1
GamblerFallacy	80	.887	.318	0	1
DispositionEffectLosses	79	.646	.481	0	1
DispositionEffectGains	79	.57	.498	0	1
OstrichEffect	79	.114	.32	0	1
Overconfidence	91	.209	.409	0	1

Annex 3 – Correlation Matrix

	ObjectiveFLI	*SubjectiveFLI*	*Age*	*Income*	*Household*	*RiskAttitude*	*Gender*	*Education*	*Experience*	*LossAversion*	*GamblerFallacy*	*Disposition EffectLosses*	*Disposition EffectGains*	*OstrichEffect*	*Overconfidence*
ObjectiveFLI	1.0000														
SubjectiveFLI	0.2812***	1.0000													
Age	-0.0535	0.0744	1.0000												
Income	0.2718***	0.1264	-0.0408	1.0000											
Household	0.0524	-0.2577**	-0.0741	0.2832***	1.0000										
RiskAttitude	0.1352	0.1733	-0.1136	-0.0016	-0.0862	1.0000									
Gender	N/A	N/A	N/A	N/A	N/A	N/A	1.0000								
Education	N/A	N/A	N/A	N/A	N/A	N/A	0.0140	1.0000							
Experience	N/A	N/A	N/A	N/A	N/A	N/A	0.3469	-0.4018	1.0000						
LossAversion	N/A	N/A	N/A	N/A	N/A	N/A	-0.0123	-0.2119	-0.1046	1.0000					
GamblerFallacy	N/A	N/A	N/A	N/A	N/A	N/A	-0.0511	0.0704	0.1779	1000	1.0000				
DispositionEffectLosers	N/A	N/A	N/A	N/A	N/A	N/A	0.0530	0.2074	-0.0462	-0.4108	0.2136	1.0000			
DispositionEffectGains	N/A	N/A	N/A	N/A	N/A	N/A	0.0545	-0.0095	0.0939	-0.3126	0.1003	-0.1778	1.0000		
OstrichEffect	N/A	N/A	N/A	N/A	N/A	N/A	-0.4242	-0.1240	-0.1165	0.4314	-0.3209	-0.1388	-0.3456	1.0000	
Overconfidence	N/A	N/A	N/A	N/A	N/A	N/A	0.1565	0.3760	-0.0409	-0.0219	0.1240	0.2696	0.1285	-0.1658	1.0000

***Significant at 1% level; ** Significant at 5% level; *Significant at 10% level

Annex 4 –Bivariate Analysis of Mean

Bivariate Analysis of Mean							
	Bivariate Analysis (t-test)	***LossAversion***	***GamblerFallacy***	***DispositionEffectLosses***	***DispositionEffectGains***	***OstrichEffect***	***Overconfidence***
Gender	Female	0,074	0,888	0,667	0,593	0,037	0,286
	Male	0,074	0,887	0,635	0,558	0,154	0,161
	Test Value (t)	0,000	-0,028	-0,279	-0,294	1,554	-1,427
	Std. Error Difference	0,029	0,035	0,054	0,056	0,036	0,042
Education	Attending a master's in Finance	0,086	0,877	0,607	0,571	0,125	0,179
	I have a master's in Finance	0,043	0,913	0,739	0,565	0,087	0,292
	Test Value (t)	0,656	-0,454	-1,109	0,050	0,470	-1,160
	Std. Error Difference	0,065	0,079	0,119	0,124	0,080	0,097
Experience	Yes	0,067	0,898	0,638	0,586	0,103	0,212
	No	0,095	0,857	0,667	0,524	0,143	0,200
	Test Value (t)	0,425	-0,507	0,029	-0,489	0,481	-0,126
	Std. Error Difference	0,067	0,081	0,123	0,128	0,082	0,097
	Bivariate Analysis (ANOVA)						
Age	Test Value (F)	0,440	1,420	0,870	1,130	0,510	1,170
Income	Up to 500€ / month	0,500	1,000	0,000	0,500	0,500	0,500
	Between 501€ and 1000€ / month	0,100	1,000	0,222	0,888	0,000	0,333
	Between 1001€ and 2500€ / month	0,065	0,806	0,733	0,533	0,067	0,294
	Between 2501€ and 4000€ / month	0,095	0,857	0,667	0,524	0,143	0,120
	More than 4000€ / month	0,000	1,000	0,765	0,529	0,176	0,056
	Test Value (F)	1,740	1,460	3,580**	1,050	1,410	1,900
Household	1	0,083	0,818	0,636	0,727	0,000	0,333
	2	0,067	0,867	0,733	0,467	0,067	0,250
	3	0,153	0,923	0,615	0,462	0,077	0,333
	4	0,060	0,909	0,563	0,656	0,156	0,108
	5 or more	0,000	0,875	0,875	0,375	0,250	0,125
	Test Value (F)	0,470	0,220	0,820	1,140	0,980	1,410
RiskAttitude	1	0,125	0,750	0,750	0,750	0,000	0,250
	2	0,077	1,000	0,615	0,654	0,115	0,219
	3	0,097	0,867	0,655	0,414	0,103	0,235
	4	0,000	0,909	0,636	0,636	0,182	0,167
	5	0,000	0,600	0,600	0,600	0,200	0,000
	Test Value (F)	0,440	2,420*	0,130	1,220	0,460	0,410
ObjectiveFli	Test Value (F)	1,53	1,08	1,37	0,81	1,24	11,340***
SubjectiveFLI	1	0,000	1,000	1,000	0,000	0,000	0,000
	2	0,000	0,000	0,000	0,000	0,000	0,000
	3	0,500	1,000	0,000	0,500	0,000	0,000
	4	0,000	0,950	0,700	0,600	0,050	0,000
	5	0,176	0,882	0,625	0,438	0,125	0,476
	6	0,000	0,889	0,667	0,667	0,111	0,276
	7	0,074	0,769	0,615	0,538	0,231	0,077
	Test Value (F)	2,870**	0,570	0,900	0,710	0,570	4,380*

***Significant at 1% level; ** Significant at 5% level; *Significant at 10% level

Annex 5 – Binary Logit Regression for each Behavioral Bias using the additional measures of financial literacy and considering Education

Binary Logit Regression																		
Variables	***LossAversion***			***GamblerFallacy***			***DispositionEffectLosses***			***DispositionEffectGains***			***OstrichEffect***			***Overconfidence***		
	Estimate (Std.Error)			Estimate (Std.Error)			Estimate (Std.Error)			Estimate (Std.Error)			Estimate (Std.Error)			Estimate (Std.Error)		
Gender	-0,766 (1,331)	-0,558 (1,287)	-0,843 (1,222)	-0,804 (1,326)	-0,779 (1,023)	-0,364 (0,964)	-0,207 (0,711)	-0,085 (0,653)	-0,122 (0,680)	0,329 (0,658)	-0,064 (0,597)	-0,103 (0,623)	-0,804 (1,326)	-1,314 (1,213)	-1,765 (1,250)	1,296 (0,822)	omitted	0,557 (0,729)
Age	-0,029 (0,058)	-0,009 (0,057)	-0,047 (0,062)	-0,034 (0,053)	0,028 -0,062	0,055 (0,069)	0,000 (0,030)	0,000 (0,030)	0,002 (0,031)	0,024 (0,029)	0,020 (0,029)	0,026 (0,030)	-0,034 (0,053)	-0,030 (0,051)	-0,045 (0,054)	0,014 (0,036)		-0,008 (0,038)
Income	-0,660 (0,498)	-0,774 (0,499)	-0,643 (0,474)	-0,116 (0,440)	0,266 (0,416)	0,110 (0,406)	0,692** (0,282)	0,715** (0,291)	0,869*** (0,319)	-0,305 (0,252)	-0,182 (0,254)	-0,428 (0,272)	-0,116 (0,440)	0,020 (0,416)	-0,244 (0,426)	-0,873*** (0,327)		-0,689** (0,318)
Household	-0,144 (0,443)	-0,104 (0,378)	-0,234 (0,407)	0,928** (0,465)	0,143 -0,318	0,247 (0,348)	-0,185 (0,235)	-0,146 (0,220)	-0,177 (0,237)	0,047 (0,222)	-0,053 (0,207)	-0,009 (0,223)	0,928** (0,465)	0,747* (0,439)	0,917* (0,484)	-0,006 (0,263)		-0,255 (0,252)
RiskAttitude	-0,708 (0,607)	-0,671 (0,599)	-0,716 (0,626)	0,290 (0,436)	-0,465 (0,425)	-0,535 (0,440)	-0,136 (0,299)	-0,096 (0,297)	-0,408 (0,332)	-0,140 (0,277)	-0,168 (0,274)	-0,280 (0,305)	0,290 (0,436)	0,211 (0,404)	0,205 (0,439)	-0,128 (0,357)		-0,066 (0,353)
Education	-0,445 (1,215)	0,012 (1,315)	-0,603 (1,241)	0,220 (1,075)	0,294 -0,980	0,477 (0,941)	0,480 (0,614)	0,329 (0,631)	0,520 (0,644)	-0,086 0,563	-0,121 (0,575)	0,183 (0,584)	0,220 (1,075)	0,214 (1,097)	0,419 (1,104)	0,722 (0,651)		0,731 (0,655)
SubjectiveFLI	0,025 (0,462)	-	-	0,567 (0,386)	-	-	-0,174 (0,246)	-	-	0,256 0,236	-	-	0,567 (0,386)	-	-	0,655** (0,316)		-
AverageFLI	-	0,012 (1,315)	-	-	-1,253 (1,203)	-	-	-0,494 (0,637)	-	-	-0,375 (0,594)	-	-	0,627 (1,175)	-	-		-
AggregateFLI	-	-	-0,403 (0,432)	-	-	0,380 (0,358)	-	-	-0,002 (0,284)	-	-	0,481 (0,285)	-	-	-0,021 (0,404)	-		-0,365 (0,271)
Constant α	2,851 (4,685)	1,227 (1,406)	3,792 (3,620)	-7,839** (3,870)	2,540 (2,958)	0,919 (3,121)	0,040 (2,402)	-0,833 (1,810)	-0,975 (1.875)	-0,504 (2,257)	1,331 (1,678)	1,781 (1,819)	-7,839** (3,870)	-4,814* (2,901)	-3,423 (2,883)	-2,768 (2,932)		1,713 (2,241)

****Significant at 1% level; ** Significant at 5% level; *Significant at 10% level*

Annex 6 – Binary Logit Regression for each Behavioral Bias using the additional measures of financial literacy and considering Experience

Binary Logit Regression																		
Variables	***LossAversion***			***GamblerFallacy***			***DispositionEffectLosses***			***DispositionEffectGains***			***OstrichEffect***			***Overconfidence***		
	Estimate (Std.Error)			Estimate (Std.Error)			Estimate (Std.Error)			Estimate (Std.Error)			Estimate (Std.Error)			Estimate (Std.Error)		
Gender	-0,805 (1,274)	-0,524 (1,297)	-0,990 (1,187)	-1,252 (1,109)	-0,843 (1,039)	-0,289 (0,957)	-0,106 (0,703)	-0,051 (0,655)	-0,029 (0,672)	0,277 (0,660)	-0,113 (0,601)	-0,093 (0,621)	-0,723 (1,275)	-1,241 (1,207)	-1,663 (1,214)	1,423* (0,810)	omitted	0,663 (0,710)
Age	-0,042 (0,060)	-0,016 (0,060)	-0,066 (0,068)	0,041 (0,069)	0,042 (0,066)	0,078 (0,077)	0,005 (0,030)	0,003 (0,030)	0,005 (0,032)	0,026 (0,029)	0,023 (0,029)	0,031 (0,031)	-0,035 (0,049)	-0,029 (0,047)	-0,045 (0,049)	0,016 (0,036)		-0,004 (0,039)
Income	-0,723 (0,490)	-0,786 (0,481)	-0,686 (0,465)	0,339 (0,408)	0,330 (0,401)	0,177 (0,404)	0,717*** (0,280)	0,747*** (0,286)	0,884*** (0,313	-0,299 (0,250)	-0,179 (0,247)	-0,402 (0,271)	-0,146 (0,430)	0,019 (0,396)	-0,272 (0,418)	-0,829*** (0,324)		-0,623** (0,308)
Household	-0,087 (0,442)	-0,093 (0,388	-0,183 (0,410)	-0,064 (0,331)	0,111 (0,313)	0,208 (0,349)	-0,222 (0,231)	-1,176 (0,212)	-0,201 (0,234)	0,043 (0,218)	-0,053 (0,200)	-0,034 (0,221)	0,939** (0,457)	0,734* (0,416)	0,924** (0,470)	-0,054 (0,255)		-0,304 (0,248)
RiskAttitude	-0,772 (0,598)	-0,681 (0,990)	-0,790 (0,626)	-0,498 (0,445)	-0,399 (0,412)	-0,436 (0,437)	-0,096 (0,292)	-0,068 (0,292)	-0,367 (0,324)	-0,136 (0,276)	-0,161 (0,273)	-0,251 (0,305)	0,273 (0,435)	0,201 (0,397)	0,134 (0,446)	-0,103 (0,356)		-0,036 (0,351)
Experience	-0,692 (1,012)	-0,681 (0,990)	-0,751 1,046	0,641 (0,884)	0,644 (0,846	0,511 (0,951)	-0,005 (0,596)	-0,011 (0,595)	-0,192 (0,681)	0,240 (0,561)	0,334 (0,559)	0,177 (0,655)	-0,559 (0,912)	-0,366 (0,868)	-0,910 (0,959)	-0,281 (0,674)		-0,054 (0,702)
SubjectiveFLI	0,114 (0,473)	-	-	-0,691* (0,395)	-	-	-0,162 (0,246)	-	-	0,242 (0,236)	-	-	0,595 (0,391)	-	-	0,676** (0,315)		-
AverageFLI	-	1,276 (1,327)	-	-	-1,393 (1,188)	-	-	-0,579 (0,623)	-	-	-0,377 (0,582)	-	-	0,625 (1,170)	-	-		-
AggregateFLI	-	-	-0,329 (0,433)	-	-	0,347 (0,367)	-	-	0,034 (0,292)	-	-	0,466 (0,291)	-	-	0,061 (0,412)	-		-0,364 (0,275)
Constant α	3,311 (4,626)	2,148 (3,711)	4,971 (4,006)	5,248 (4,387)	1,611 (3,193)	-0,337 (3,683)	-0,147 (2,429)	-0,853 (1,907)	-0,893 (2,056)	-0,679 (2,301)	0,971 (1,798)	1,478 (2,037)	-7,384* (3,888)	-4,456 (3,012)	-2,398 (3,037)	-2,635 (2,956)		1,649 (2,400)

****Significant at 1% level; ** Significant at 5% level; *Significant at 10% level*