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Universidade de Lisboa

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DISSERTATION

AN ESSAY ON FINANCIAL LITERACY AND BEHAVIORAL BIASES: EVIDENCE FROM PORTUGUESE INVESTORS

AHMED ALHUSRI

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ABSTRACT

Financial literacy and behavioral biases have a crucial impact on decision-making process of individuals. We aim to understand the relationship between financially literate Individuals and their corresponding behavioral biases. Several studies have shown that cognitive errors are linked with decision-makers' financial knowledge. However, this relationship between our variable of interest were not studied in the Portuguese markets. In addition, even with financial educational programs implemented in Portugal in 2011), financially literate individuals are still not reflecting negatively on behavioral biases in 2018. This raises the question if any other variables could associate with better financial behavior during the decision-making process.

We use a database from the CMVM - Comissão do Mercado de Valores Mobiliários (Portuguese Securities Market Commission) for Portuguese investors. The total sample contains 2311 participants, where we were able to construct several indices to measure behavioral biases and financial literacy. Financial Knowledge was divided into two segments: An effective one measured by classical measures and a subjective one measured by self-evaluation standards. We did not find a standing one-way relationship between financial literacy and behavioral bias. Effective financial knowledge is only negatively associated with loss aversion and disposition effect (Gains). Moreover, demographic features such as Age, Gender, Income, educational level, risk perception, and experience appear to be statistically significant related to our behavioral biases in this paper.

Keywords: Behavioral Bias; Financial Literacy; Risk; Portugal.

JEL Code: G40; G41; G53

RESUMO

A literacia financeira e os vieses comportamentais têm um impacto crucial no processo de tomada de decisão dos indivíduos. Nosso objetivo é compreender a relação entre indivíduos alfabetizados financeiramente e seus respectivos vieses comportamentais. Vários estudos têm mostrado que os erros cognitivos estão ligados ao conhecimento financeiro dos tomadores de decisão. No entanto, esta relação entre a nossa variável de interesse não foi estudada nos mercados portugueses. Além disso, mesmo com programas de educação financeira implementados em Portugal em 2011), os indivíduos financeiramente alfabetizados ainda não refletem negativamente nos vieses comportamentais em 2018. Isto levanta a questão de se alguma outra variável poderia estar associada a um melhor comportamento financeiro durante o processo de tomada de decisão.

Utilizamos uma base de dados da CMVM - Comissão do Mercado de Valores Mobiliários para investidores portugueses. A amostra total contém 2311 participantes, onde fomos capazes de construir vários índices para medir vieses comportamentais e literacia financeira. O Conhecimento Financeiro foi dividido em dois segmentos: um efetivo medido por medidas clássicas e um subjetivo medido por padrões de autoavaliação. Não encontramos uma relação unilateral permanente entre alfabetização financeira e viés comportamental. O conhecimento financeiro eficaz está apenas negativamente associado à aversão à perda e ao efeito de disposição (Ganhos). Além disso, características demográficas como idade, gênero, renda, nível educacional, percepção de risco e experiência parecem ser estatisticamente significativas relacionadas aos nossos vieses comportamentais neste artigo.

Palavras-chave: Behavioral Bias; Letramento financeiro; Risco; Portugal.
Código JEL: G40; G41; G53

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GLOSSARY

ASF - Insurance and Pension Funds Supervisory Authority

CMVM - Portuguese Securities Market Commission

Complex-FLI – Advanced Financial Literacy Questions (Bonds, Risk Diversification and Capital Guaranteed)

DEG – Disposition Effect (Gains)

DEL – Disposition Effect (Loss)

DHS - Dutch Household Survey.

EU – Expected Utility

FLI – Financial Literacy Index

INFE - International Network on Financial Education

OE – Ostrich's Effect

PCA - Principal Component Analysis

Risk-FLI – Interaction Between Risk and Complex Financial Literacy Questions

RSP - Retirement saving plans

SEK - Swedish krona

Self-FLI – Knowledge Self-Evaluation Question

Simple-FLI – Simple Financial Literacy Questions (Inflation and Numeracy)

1. INTODUCTION

Traditional finance theories arise based on the Expected Utility (EU) theorem (MORGENSTERN & VON NEUMANN, 1953) and Modern Portfolio Theory (Markowitz, 1952), which takes into account market efficiency and investor's rationality. However, the latter assumption is questionable since market anomalies exist, such as bubbles. (Kahneman & Tversky, 1979) criticized Expected Utility (EU) theorem. They suggested that studying phycology and social science theories can explain market anomalies. Based on that, a new theorem arises called behavioral finance that relates to people's actual behavior in a financial setting. Authors such as (Sjöberg, 2000) state that behavioral biases are irrational beliefs that unintentionally impact decision-making. Based on that, researchers recognize the natural effect of behavioral biases on investors' decision-making process.

Several studies relate behavioral biases with Individual characteristics such as demographical characteristics of the investors. On the other hand, other studies, such as the one done by (Capuano & Ramsay, 2011), concluded that non-optimal investment decisions are derived from poor financial experience and knowledge levels. Consequently, researchers start to link the phycological biases of decision-makers with their financial literacy levels.

The main cognitive errors studied by the Behavioral finance literature, and this paper alike, are Loss aversion, Gambler fallacy, Disposition effect, and ostrich's effect. To have a broad point of view, we have distinguished disposition effect in terms of gains and losses. Thus, the main questions that we aim to answer through this paper are: What are the main drivers of behavioral biases? And whether financial knowledge can help to mitigate the occurrence of these behavioral biases in investors through their decision-making process?

We will use a database from the (CMVM) Comissão do Mercado de Valores Mobiliários (Portuguese Securities Market Commission) based on a survey of Portuguese investors. The survey was conducted online for 49 days (from 18 June 2018 to 6 August 2018). The database contains questions regarding demographics such as Age, Income, Gender. Also, the survey collects people's behavioral biases and financial literacy

measures. The former was measured by technical questions, while the latter was measured by classical standards used in previous literature.

We construct several indices to measure financial knowledge and behavioral biases. Indeed, we have distinguished between two elements of financial literacy measures: Effective financial literacy measured by classical criteria; and subjective financial literacy measured by a self-assessed question. In that matter, we will observe the relationship between people who actually know and people who think they know. First, the results reveal that Risk perception negatively impact Loss aversion, and factors such as Age and educational Level increases the odds to be prone to loss aversion. Second, we found that none of the independent variables have any significant relation to the gambler fallacy behavioral bias.

Regarding disposition effect; Age is negatively associated with disposition effect (loss), and, Income, Risk perception, and Experience increase the odds of holding your "loosing" investment. On the other hand, disposition effect (Gains) is affected positively by Age and education levels. We found that males and risk-lovers have less chance to be prone to disposition effect (Gains). We discovered that the disposition effect can explain prospect theory. Lastly, being old; male; and highly educated seems to affect negatively on ostrich effect behavioral bias. In terms of financial literacy, the result reveals that Effective financial literacy can mitigate the chance to be prone to loss aversion and disposition effect (Gains), but it increases the odds to incur disposition effect (Loss). Subjective Financial knowledge can mitigate Ostrich's effect; however, it increases the odds to be prone to disposition effect (Gains).

Our work contributes for literature in several ways. First, we have a further evidence on the relationship between behavioral biases and financial literacy as observed by (Ateşa et al., 2016); (Baker, Kumar, Goyal, & Gaur, 2019); (Özen & Ersoy, 2019). Second, we are studying several behavioral biases with several financial literacy measures. Lastly, we provide reconciliation for mixed previous evidence from previous literature on the same sample, which means, less sampling bias.

This study is structured as follows: in section 2, we examine the existing literature about the relationship between behavioral biases and financial literacy, with

demographical features of investors across countries. Section 3 describes the hypothesis of our study and what we test in each analysis. Section 4 illustrates the methodology to obtain the data used. Finally, Section 5 presents descriptive data analysis and model results and Section 6 conclude and summarizes.

2. LITERATURE REVIEW

The Expected Utility (EU) theorem (Morgenstern & Von Neumann, 1953) is considered the basis of preference under risk and uncertainty. The theory suggests that optimal choices of the decision-maker are achieved through the satisfaction of four axioms: completeness, transitivity, independence, and continuity. Accordingly, an individual's optimal decisions when faced with different choices subject to various levels of probabilities are the ones that maximize the expected value of the utility. After that, investors will be able to rank outcomes accordingly to their preferences. While (Kahneman & Tversky, 1979) propose an alternative model called prospect theory that criticized expected utility theory. The decision-maker will be able to choose among alternative prospects, which can be interpreted as risky outcomes. They have replaced probabilities with decision weights and assign gains and losses rather than final assets, and investors eventually apply specific heuristics while making decisions. Their main conclusion is that investors become risk seekers when realizing gains, while they become risk-averse after suffering losses.

Another theory that gained popularity as an alternative model to the expected utility theory is the regret theory (Loomes & Sugden, 1982). The theory suggests that when the decision-maker chooses among different risky investment opportunities, their concerns will be focused on the payoffs and foregone outcomes that could occur if they choose otherwise. Based on that, two functions could be studied to observe people's choices: utility function towards outcomes and a function that captures the regret effect.

As such, traditional finance theories such as the Expected utility (EU) theorem (Morgenstern & Von Neumann, 1953) and Modern Portfolio Theory (Markowitz, 1952) considers market efficiency as well as investor's rationality. However, such efficiency is questionable as the stock market anomalies exist, such as bubbles.

To better understand these phenomena, many scholars such as (Kahneman & Tversky, 1979), who laid the foundation of prospect theory, suggested that studying phycology and social life theories can explain market anomalies. Besides, it could reveal further information on efficiency in the financial markets. (Thaler, 1980) studies prospect theory based on an alternative descriptive approach; he argues that investors are affected by behavioral biases, leading to less optimal decisions. Thus, a new paradigm in finance was introduced, called behavioral finance, which examines phycological variables that impact and sometimes deceive investment decisions. Behavioral finance is concerned with the changes in the decision-making process that deviate from rational decision-making behavior.

In contrast, traditional finance is related to people's wealth maximization behavior, while behavioral finance concerns people's actual behavior in a financial setting (Nofsinger, 2005). Behavioral biases are irrational beliefs that unintentionally impact decision-making, it plays an outstanding role in situations that involve risk assessment (Sjöberg, 2000). These behavioral biases lead investors to undertake cognitive errors (Hirshleifer, 2001).

According to (Tversky & Kahneman, 1973) and (Tversky & Kahneman, 1974), investors tend to utilize "heuristics" in their decision-making process. Heuristics demonstrate the tendency of investors to make quick judgments when making decisions. They tend to use trial and error methods to process complex information used for making investment actions. (Chandra, 2008) has found that heuristics influence more investment decisions than biases.

Although current literature argues that various factors affect investors' behavior, Loss Aversion, Gambler's Fallacy, Disposition Effect, and Ostrich's Effect could be seen as the most important and studied behavioral biases that influence people's investment decisions.

Cognitive biases are essential in a situation that involves risk management (Sjöberg, 2000), as biases such as loss aversion (Tversky & Kahneman, 1991). Loss aversion is a frequently documented behavioral bias in phycology and economics, concluding that people tend to abhor losses more than they like comparable gains. This preference leads

to a choice for avoiding losses instead of evaluating the opportunities of achieving potential earnings (Bondt & Thaler, 1985). As such, an incurring loss indicates more disutility than a corresponding gain provides utility at the same moment (Kahneman & Tversky, 1979). Loss aversion leads people to take even more risks to compensate for previous losses to recover them, which may lead to the opposite desired way (incurring more losses). As a result, investors become risk-seekers when faced with gains and risk-averse in the case of losses (Ngoc, 2013). (Kleinübing Godoi, Marcon & daSilva, 2005) through exploring interview concluded that feelings of guilt, fear and anguish, rationalizations, risk dimensions, and familiar influence are associated with the feeling of loss aversion.

Additionally, loss aversion impacts lowering participation in the market as newcomers will avoid participating to avoid incurring more losses, neglecting the opportunity to collect future potential gains. Also, when faced with a noticeable loss, Tunisian investors seem to behave as risk-takers (Rekik & Boujelbene, 2013).

Gambler's Fallacy is an irrational belief that occurs when an investor's false impression that the independent trials of a random process are negatively correlated (Tversky & Kahneman, 1971). The concept of gambler's fallacy purely explains irrational behavior that we use in our daily life, beyond the gambling context (Chen, Moskowitz & Shue, 2016). For instance, if a coin toss "Heads" three times, an interesting number of people assume that the next flip would be "tails". The latter example has similarities to what was done by (Dohmen, Falk, Huffman, Marklein & Sunde, 2009). They presented a questionnaire with 8-coin flips. Eventually, results show that more than 20% of the respondent individuals have answered that there is less than 50% chance of the final three-coin flip outcome. Also, (H M Rakesh, 2013) has documented gambler's fallacy in similar ways. These experiments have been done through surveys of lotteries and casinos. Thus, it has its disadvantages of participation selection, which may differ if the general population sample were involved, not only the individuals going to casinos and participating in lotteries.

The disposition effect is a critical behavioral bias in behavioral finance since it leads to costly outcomes. Individual investors who show this bias usually don't hold a well-diversified portfolio. (Sherfin & Statman, 1985) have labeled the so-called disposition

effect in which investors sell stocks that have appreciated (winners) and at the same time hold stocks that have depreciated otherwise (losers). Thus, investors hold losers while disposed of winners.

The disposition effect has a direct implication on (Kahneman & Tversky, 1979) prospect theory. While the prospect theory has its value function concave for gain and convex for losses, implying a risk-averse behavior towards gains and risk-seeking towards losses. Disposition Effect bias combines individual stock appreciation and depreciation with the value function of prospect, suggesting a prediction indicator that shows investors sell winners and preserve losers in their portfolios.

However, does the prospect explain the disposition effect? A question that (Hens & Vlcek, 2011, p.153) answered: " Prospect theory can indeed explain ex-post disposition behavior but not ex-ante disposition behavior".

Different authors have studied the presence of such bias in several geographic areas. (Barber, Lee, Liu & Odean, 2007) found that almost 84% of the Taiwanese investors tend to sell gaining stocks faster than losing stocks. As well, (Brown, Chappel, Rosa & Walter, 2006) have positively concluded this behavioral bias in Australia.

Lastly, Ostrich's effect (Galai & Sade, 2006) is a phycological bias discovered by observing the positive relationship between liquidity and market information. Ostrich's effect is the tendency of people to avoid uncertain scenarios by assuming they don't exist. However, (Karlsson, Loewenstein & Seppi 2009) broader the concept by saying that people avoid physiological discomfort by evading exposure to negative information. Ostrich's effect mainly consists of two components: the first one is the tendency of people to pretend that unpleasant information doesn't exist, and the second is its effect on prices in the financial market. Individual investors practice ignorant emotions towards their portfolios through a downturn in the market (Galai & Sade, 2006; Karlsson et al., 2009; Sicherman, Loewenstein, Seppi & Utkus 2016). As a result, they tend to monitor their portfolios more when markets are optimistic and vice versa when it's not (Karlsson et al., 2009).

A review of behavioral biases research indicates that an investor's irrational behavior may be influenced by demographics and socioeconomic profile, personality type, and psychological constructs. Authors have been able to prove that gender differences affect gambler's fallacy bias. (Suetens & Tyran, 2011) using data from lottery gambling has studied gender differences in gambler's fallacy. They have concluded that men, but not women, are less likely to pick up lottery numbers that occurred in last week's lottery drawn. Also, (Dohme et al., 2009) find that biased beliefs are more prone to women than men regarding hypothetical coin tossing.

Additionally, the socio-economic and demographical variables have an important impact on the disposition effect. Gender differences can play a significant role in differentiating the disposition effect among a group of investors. As such, (Rau, 2014) has illustrated that females are prone to a higher disposition effect than men. (Talpsepp, 2010) concluded that different ages and gender have differences in disposition effect bias. And, this bias is very similar for female and male investors after controlling other variables such as trading and performance.

In the Portuguese case, using a database from the top three Portuguese banks, (Abreu, 2018) has studied, based on ten-year periods, warrants trading in financial markets. The results show that the disposition effect and gambler's fallacy increase as trading frequency increases.

On the other hand, (Bogan, Just, & Dev, 2013) studied portfolio choices within team decision making based on gender. They observed that a team consisting of men only is more willing to increase loss aversion bias, while a mixture of females and males is neither loss averse nor risk-seeking. And, loss aversion will be more prevalent in older people (Gächter, Herrmann & Johnson 2021). Moreover, (Talpsepp, 2010) concluded that foreign investors have a higher loss aversion than local investors.

There are limited studies about the association between ostrich's effect and individual characteristics. However, (Sicherman et al., 2016), using data for 401(k) accounts in 2007 and 2008, found that ostrich's effect is a stable behavioral bias regarding personal characteristics of individuals. The reasoning behind that, individuals who have shown this behavioral bias in 2007 are more prone to display it in 2008. On the other hand, (Baars

& Tapper, 2018), using data from Länsförsäkringar bank in Sweden, have found no indication of ostrich's effect.

Based on that, we can say that age, gender and income factors could affect behavioral biases. However, an interesting number of authors have studied the impact of experience on the presence of specific behavioral biases. (Gupta & Ahmed, 2016) found that loss aversion bias is more prevalent in experienced individuals than inexperienced ones. (Dhar & Zhu, 2006) studied the US discount broker from 1991-1996, and have shown that the disposition effect is weaker in investors who are considered employed in a professional occupation or are considered wealthy. The reasoning behind that is that older, more experienced investors seek stronger diversification, possess a lower frequency of trading, perform analytical analysis, and exhibit weaker behavioral biases. Results similar to the latter have been demonstrated by (Talpsepp, 2010).

Also, (Bernard, Cade & Connors, 2020), using cannabis dispensaries data, have found that managers tend to avoid pessimistic news when they expect it will impact their store's performance. While, (Chen, Kim, Nofsinger & Rui, 2007) examined the Chinese market from 1998-2002 have shown that middle-aged investors suffer more from the disposition effect and show a negative pattern between disposition effect with trading frequency and account volume.

Not only do individuals' characteristics seem to influence behavioral biases, but also a high amount of studies has started to focus on people's financial literacy levels and behavioral biases. Financial literacy is a growing concept that has been globally recognized as a crucial element of financial stability and development (INFE, 2009). Financial literacy is the ability to be rational when making personal financial planning decisions, such as pensions and wealth accumulation, taking the economic environment into consideration (Lusardi & Mitchell, 2014). In other words, an individual who uses the knowledge of money, insurance, banking, losses and gains, notions about risk, and taxes to make their financial decision is considered financially literate (Hira, 2009).

Through the literature, there is no uniform definition for financial literacy. However, (Lusardi & Mitchell, 2014) argue that decision-makers who have financial knowledge, but cannot use it properly to make rational decisions, are defined as financial illiterate.

Thus, to make sound financial decisions authors such as (Atkinson & Messy, 2012) define financial literacy as a combination of knowledge, awareness, attitude, skills, and behavior that are necessary to achieve the financial wellbeing of an individual.

In Portugal, the financial education national plan was first released in 2011 with an expected time frame until 2015. It aims people adopt an appropriate financial behavior, using educational projects, which increase the level of financial knowledge of the population and increase the stability of the financial system (Conselho Nacional de Supervisores Financeiros, 2011). Currently, the plan is in its second phase covering from 2016 to 2020, regulated by three primary financial regulators: Portuguese Securities Market Commission (CMVM); Central Bank of Portugal (BdP); and Insurance and Pension Funds Supervisory Authority (ASF).

According to (Ouachani, Belhassine & Kammoun, 2021), measuring a variable as subjective as financial literacy can take different approaches. Subjective financial literacy refers to an individual's level of financial confidence and tests an investor's perceived knowledge (French & McKillop, 2016). One approach is evaluating the self-assessed financial knowledge by asking a single question with a Likert scale which determines how respondent identify their financial literacy level. Other approaches, like (Klapper, Lusardi & Van Oudheusden, 2015), have identified 4 financial questions regarding risk diversification, calculation of simple and compound interest, and inflation. Consequently, if the respondent could answer 3 out of 4 questions, he/she is considered financial literate. Their global results show only 33% of adults are referred to as financially knowledgeable, while Portugal has 23%, below the average European rate scoring 26%, which is considered the second-lowest rate within European countries.

A review of financial literacy research indicates that demographics and socioeconomic characteristics may influence an investor's perception of knowledge. As such, authors have studied gender differences based on the level of financial knowledge of individuals. Consequently, consistent results show that women are less financially literate than men (Abreu & Mendes, 2009; Hassan Al-Tamimi & Anood Bin Kalli, 2009). One exciting explanation for these outcomes is that females answer more "don't know" than males across countries. The latter explanation was documented by (Bucher-Koenen, Lusardi, Alessie & Rooij, 2017), who have studied questionnaires of financial knowledge from

three different countries: the United States, the Netherlands, and Germany. They concluded that women were more like to answer "don't know" by 17% in the Netherlands and 7% in the United States and Germany.

Even though (Lusardi & Mitchell, 2014) have proven this gender pattern across countries, (Ateş, Coşkun, Demircan & Coşkun,2016) have shown, using 596 individual stock investors in turkey, that females are prone to higher financial knowledge levels than males. Finally, (Sezer & Demir, 2015) found that gender doesn't influence the level of financial literacy.

Not only gender seems to influence financial literacy, but age also. According to (Lusardi & Mitchell, 2011a), younger people acknowledge that they knew few. In contrast, older people tend to rate themselves as very knowledgeable, but they are less literate than the average. Financial literacy levels seem to increase with age; however, once reached its peak it decreases again for older adults (Cupak, Fessler, Silgoner & Ulbrich, 2018). While other authors have failed to support the latter results and concluded that retirement age has higher financial knowledge levels than working-age investors (Ateşa et al., 2016).

So far, decision-makers who are considered financially knowledgeable, use this knowledge and rely on financial advice to make a financial decision. In contrast, financially illiterate rely basically on informal sources such as advice from family and friends, according to Dutch Household Survey (DHS). Thus, we can say that financial literacy has an impact on investment decisions. As such, (Capuano & Ramsay, 2011) have concluded that non-optimal investment decisions are derived from poor levels of financial experience, psychological factors, inertia, and insufficient savings. Based on that, they suggested that an increase in the level of financial confidence through educational programs, could mitigate irrational behaviors due to biases and heuristics.

Consequently, (Jonsson, Söderberg & Wilhelmsson ,2017), using a sample of Sweden people with yearly average earnings of 414,000 SEK (40,500 euro) or more, found that individuals with high levels of educational backgrounds tend to sell shares in funds that performed poorly. Thus, the higher the levels of financial confidence, the lower the tendency for disposition effect bias. The same results have been found in (Dhar & Zhu,

2006) researches. In general, there is a positive association between financial literacy and mental accounting (Baker et al., 2019). While, there is a negative association with overconfidence, loss aversion, framing, and cognitive (Ateşa et al., 2016).

Part of the literature starts to observe a specific pattern of behavioral biases that exist in financially literate person and not in financially illiterate. For example, (Özen & Ersoy, 2019) used a sample of 444 respondents to a financial questionnaire consisting of university students and financial institution employees. They observe that Conservatism bias, mental accounting, and framing biases are prone to students who don't take finance courses. In contrast, conservatism bias tends to increase in people who are considered professionals.

According to (Hsu, Chen b, Huang, & Lin, 2021), financial literacy can mitigate gender differences in investment behavioral biases. They collected data from market research firm "Pollster", and studied more than 1,215 questionnaires. Their interesting conclusion is that when "men exhibit stronger biases than women, gender differences reduce and no longer exist when the sample is restricted to individuals of high financial literacy". In contrast, if women are prone to stronger biases than men, then "the gender gap widens among individuals of high financial literacy". "This implies that the learning effect of financial literacy on behavioral biases is larger in men than in women". (Hsu et al., 2021, p.6).

3. RESEARCH HYPOTHESIS

This paper will aim to test what are the main drivers of behavioral biases. We also analyze whether the increase of financial literacy levels can mitigate individuals' cognitive biases in the Portuguese market.

In general, most researchers and practitioners have found that males are more financially literate than females, loss aversion bias is more prevalent in experienced individuals than inexperienced ones, and the disposition effect is weaker in investors considered professional or wealthy. However, some literature also does not support the latter beliefs. Therefore, further research needs to clarify mixed evidence.

In addition, most of the research papers have focused their studies on countries such as United States or China. In comparison, Portugal is considered a developed country with an illiquid stock market, and has a prevalence of investing in riskless assets such as deposits. Thus, we need to understand through the endogenous sample for countries such as Portugal the association between its people's behavior, financial knowledge, and characteristic to understand their investment behavior.

The contribution of this paper is to provide additional evidence on the impact of financial literacy on the behavioral biases of individuals in the Portuguese market. Through regression analysis, it will try to understand the relationship between Individual characteristics, financial literacy, and behavioral bias. And conclude whether financial literacy can play a moderating factor to mitigate behavioral biases of investors. The selected behavioral biases will be the following: Loss Aversion, Gambler's Fallacy, Disposition Effect, and Ostrich's Effect. The study will attempt to classify investors to groups into different segments according to their demographic features and psychological biases.

First, we need to clarify the potential drivers of the four behavioral biases. We call this proposition **H1**, which will mainly be on personal characteristics such as Educational level; Experience; Risk perception; Income; Financial literacy; Gender; and Age.

H1*: Educational level; Experience; Risk perception; Income; Gender; and Age Impact Loss Aversion, Gambler's Fallacy, Disposition Effect, and Ostrich's Effect.*

The second hypothesis **H2**, is related to the specific case of the association between behavioral bias and financial literacy levels. We will aim to test whether this association is negative or positive between the level of financial literacy and the four behavioral biases - Loss Aversion, Gambler's Fallacy, Disposition Effect, and Ostrich's. We will consider two financial literacy measures: Effective, measured by classical standards, and Subjective measured by self-assessed evaluation. In that matter we can observe the direct effect from two perspectives: people who actually know and people who believe they know. Indeed, if the association is positive, then the increase in financial literacy will increase the occurrence of the behavioral biases. Otherwise, it will mitigate the occurrence of the behavioral biases in individuals.

***H2**: An increase in Effective and subjective financial literacy levels will have an influence on mitigating the four behavioral biases Loss Aversion, Gambler's Fallacy, Disposition Effect, and Ostrich's Effect in individuals Investors.*

Following the critical impact of Risk attitude on the behavioral bias, we will use the interaction between risk attitude and financial literacy as a moderating variable when analyzing Financial literacy and behavioral biases association. Thus, we can observe the linear relationship of each variable, as well as the effect of both variables at the same time. We call this Hypothesis **H3**.

***H3**: The moderating impact of the interaction between Risk perception and financial literacy will influence the relationship between* financial literacy and behavioral biases.

4. DATA SAMPLE & DESCRIPTIVES

Our database was obtained from the (CMVM) Comissão do Mercado de Valores Mobiliários (Portuguese Securities Market Commission) for Portuguese investors. The survey was conducted online for 49 days (from 18 June 2018 to 6 August 2018). On average, each participant took 18 minutes to complete the survey.

In the survey, we can observe three main elements of measurement regarding financial literacy: (a) Numeracy; (b) primitive financial literacy, related to macroeconomic factors such as inflation; (c) sophisticated financial literacy, mainly on complex questions regarding bonds, risk diversification, and guaranteed capital. For that reason, we will aim to differentiate between Simple and complex financial literacy questions following the Van Rooij, Alessie & Lusardi (2011) methodology. The reason behind breaking the financial literacy question into two parts is that, according to several studies, financial literacy advanced questions are what matter the most (Lusardi & Mitchell, 2011b). Also, the capacity to calculate with more advanced questions is correlated with financial decisions, as pointed by Lusardi & Mitchell (2014).

Authors such as Van Rooij et al. (2011) have performed factor analysis on a sample of 16 financial literacy questions to construct two literacy indices, Simple-FLI and Complex-FLI. Factor analysis and Principal Component Analysis (PCA) are techniques

that create new uncorrelated variables that eventually succeed in maximizing the variance (Jolliffe & Cadima, 2016). In addition, the user of the latter analysis can use them to reduce their intended dataset dimensions, thus, minimizing information loss.

Factor analysis and PCA differentiate in their mathematics application. Factor analysis assumes that a latent factor exists for the observed data. At the same time, PCA identifies variables that constitute the observed variable. For that reason, and since our purpose is to minimize our 5 financial literacy questions into two categories, we will use the PCA in our paper to construct two financial literacy Indexes: Simple-FLI and Complex-FLI. We apply a rotation by varimax. Rotation is "a procedure in which the eigenvectors (factors) are rotated in an attempt to achieve simple structure." (Bryant & Yarnold, 1995, P. 132). By doing this, factors tend to load different variables, Minimum three variables. These variables will constitute the indices we are trying to build for the Simple and Complex financial literacy questions. The variables will take place according to the number of correct questions the participants have answered. For example, for the Complex-FLI (Contain three questions regarding Bonds, risk diversification, and guaranteed capital), if the participant could answer three questions, they will have a value from the stated three variables above (positive value). On the other hand, if the participant answered zero questions, they will assign a negative value from the three variables listed above, which indicates that the participant is below average. In addition, the third index will be based on self-assessment knowledge questions asked to the respondents (Self FLI). In that matter, we can notice that we have two main elements for financial literacy: Effective literacy measured by classical measures; and Subjective Literacy. Consequently, we can distinguish between what decision-makers actually know (Effective) and what they believe they know (Self assessed). Moreover, we have taken into account distinguishing the difference between questions answered "Incorrectly" and "don't know" answers so we can be able to differentiate degrees of financial knowledge as mentioned by Lusardi & Mitchell (2006). The percentages of accuracy per question are shown in **(Table 1)**.

The survey allows us to test for the presence of the four behavioral biases that we analyze: Loss Aversion, Gambler's Fallacy, Disposition Effect, and Ostrich's Effect. The questions are designed based on testing investor's cognitive processes. For example, the ostrich's effect questions are based on how usually a person monitors their portfolio

during positive/ negative market conditions. Indeed, if the respondent answers that they don't often monitor their portfolio performance during economic downturn periods while monitoring it more often during booming and recoverable economic prices, then they possess the ostrich's effect. The complete behavioral biases questions are found in **(Table 2)**. Based on that, we will build four behavioral biases indices that will depend on the number of people who have the stated behavioral biases above according to their answers.

In addition, we will aim to divide the sample into more experienced individuals and less experienced individuals. According to the survey, Individuals will be considered investors as long as they possess at least one of the following financial securities: Shares; Bonds; Investment funds; Saving certificates; Treasury certificates; Retirement saving plans (RSP); Commercial paper; Complex financial products; Treasury bonds; Investment in Bitcoins, ICOs or other digital currencies; and Investment in crowdfunding. Based on that, we will be able to split the sample into two categories. Indeed, the more experienced individuals are the ones who have at least one of the financial securities above.

The data sample comprised 2381 individual respondents. However, according to CMVM, 70 of the responses were considered invalid. Thus, the final model includes 2311 participants. Out of this total of respondents, 1546 (66.9%) are classified as investors (as they had a portfolio of at least one financial asset) and the remaining 765 (33.1%) as non-investors. Approximately 65% of the respondents were identified as they had completed the questionnaire. In other words, 7 out of 20 participants have answered only some questions in the survey, which is why the number of valid responses varies depending on the question.

The most frequent characteristic are men (81.8%), from 41 to 50 years old (26%), holding a university degree (42.4%), who have a master degree or Ph.D. (24.5%), employees (60.5%), retired (15%) and with a monthly income of the household between € 1001 and € 2500 (42.3%). While, women (18.2%), from 41 to 50 years old (28.7%), holding a university degree (49.9%), have a master degree or Ph.D. (26.3%), student (48.9%), retired (17.3%) and with a monthly income of the household between € 1001 and € 2500 (35.6%). **(Table 3)**

We can observe that experienced investors invested primarily in treasury bonds (44.4%); Retirement saving plans (40.7%), and shares (40%). In comparison, the least represented financial assets were commercial papers (1.6%); Investment in Bitcoins, ICOs, or other digital currencies (6.45%), and Investment in collaborative financing (crowdfunding) (7.8%). Indeed, males always dominate the percentage of investment in financial assets with (90%) in bonds and (88.1%) in investment funds.

Bearing in mind that, younger experienced investors (under 30 years old) invest primarily in Bitcoins, ICOs, or other digital currencies (23.5%) and Crowdfunding (23.2%). At the same time, middle-aged investors (between 31 and 60 years old) invest mostly in retirement savings plans (77.3%) and complex financial products (72.3%). On the other hand, experienced old age investors (above 61 years old) seem to invest mainly in Bonds (28.5%); commercial papers (27.8%); and saving certificates (23.7%).

In addition, experienced investors with a monthly income of household up to € 500 invest most in treasury bonds (5%). While, as the monthly income of the households starts to increase to reach more than € 4000, the investment patterns change to reach its peak in Bonds (23.6%), and the least financial securities investment in this income category belongs to Bitcoins, ICOs, or other digital currencies (12.1%).

We can observe that financial literacy questions regarding inflation and bonds have the highest rates of accurate answers with (89.3%) and (81.5%) respectively. While (63.4%) of the respondent have answered the numeracy question correctly, followed by risk diversification question (51.1%). On the other hand, capital guaranteed has the highest incorrect and don't know answers (72.3%). The percentages of accuracy per question are shown in **(Table 1)**.

According to the figures, participants who were able to answer 3 out of 5 questions (20.3%) are males and (4.4%) females. It is worth mentioning that middle-aged people (between 31 and 60 years old) have the highest correctly answered rates to almost all the five questions, with (22.7%) answering 4 out of 5 questions. Also, figures show that younger age participants (below 30 years old) have the least representative percentage of accuracy in the financial literacy questions, that could be, as decision-maker age increases, their knowledge increase, as well, their financial participation. In addition,

experienced investors seemed to dominate the percentage of correct answers, with an interesting gap between them and non-investors (inexperienced investors). For example, experienced investors were able to score 4 out of five questions by (24.9%), on the other hand, only (7.4%) out of non-investors were able to score 80 out of 100 points.

Regarding the (Simple-FLI) and (Complex-FLI) indices, it is worth noting that the highest figures are shown for participants who were able to answer 2 out of 2 questions in the case of Simple-FLI (61.7%) and (40.2%) for advanced questions. Moreover, the Simple-FLI and complex-FLI percentage of correct answers increase as education increases. This can confirm the validity of our index's construction. Those with the lowest level of basic and advanced financial literacy knowledge score the lowest accuracy rates. While, those who have completed higher education (University degree) or have master, Ph.D., and MBA have the highest percentage of correct answers with 46.8% being able to answer all basic FLI, and 28.5% being able to answer 2 out of 3 questions in the advanced FLI. On the matter of self-FLI, we can note that participants consider themselves as average knowledgeable (42.1%), and 9.3% consider themselves as very knowledgeable. We notice that people who consider themselves as very knowledgeable and average knowledgeable are middle-age and older people (81.5%), but younger people seem to rate themselves mostly as average knowledgeable (34.9%). We could link this to more confidence in Middle-aged and older people in terms of knowledge. We can confirm that males and females mostly rate themselves as average knowledgeable by 34.9% and 6.4% respectively. Also, 41.5% of investors rate themselves as average knowledgeable, and as very knowledgeable (9.1%).

Considering the four behavioral biases we have in the sample, Loss Aversion, Gambler’s Fallacy, Disposition Effect, and Ostrich’s Effect, we can observe that almost 1 out of 4 respondents have loss aversion bias; which are males (73.4%); Middle-aged (from 31 to 60 years old) (71.1%); considered as experienced investors (70.1%); and their monthly household's income is between € 1001 and € 2500 (45.2%). In addition, we note that loss aversion increases for the lowest education categories and for people who hold a bachelor's degree. However, this upward direction decreases for people who hold a master's, Ph.D., and MBA, to reach 20.3%. Also, as similar to the latter pattern, is

observed in the age category. That could be linked to the fact that loss aversion decreases as age and education increase to some levels.

Regarding Gambler's fallacy, 42.2% out of the sample possess this phycological bias; being Males (82%); Middle-aged (from 31 to 60 years old) (69.2%); experienced investors (66.1%); and their monthly households' income is between € 1001 and € 2500 (39.8%). Mainly, among the most educated people who have the Gambler's fallacy are those who hold a university degree (43.2%), followed by individuals who hold a master's, Ph.D., and MBA (24.7%).

Moreover, the survey tests also for the disposition effect in two domains: losses and gains. Indeed, 72.7% tend to hold to their losing investments (losses); which are males (86.1%); Middle-aged (from 31 to 60 years old) (71.1%); are experienced investors (82.4%); and their monthly households' income is between € 1001 and € 2500 (42%). While 51.4% tend to sell the investment that has been appreciated in value (Gains); namely, Males (78.1%); Old age people (above 60 years old) (20.1%); are not experienced (32.7%); and their monthly households' income is between € 2501 and € 4000 (26.2%). According to the figures, we observe that those who have a master's, Ph.D., or MBA tend to hold their losing investment more than selling their winning investments by 5.6%.

Lastly, ostrich's effect data shows that there are 56.5% respondents that monitor their portfolio performance a lot during booming market conditions. While 42% out of the sample monitor less frequently their portfolio performance during market downturn conditions. However, for ostrich's effect to take a toll, the participant should do the latter actions simultaneously. By matching those, we have only 61 participants who possess ostrich's effect (2.6%); Males (84.7%); Middle-aged (from 31 to 60 years old) (80%); are experienced investors (96.7%); hold a bachelor degree (48.3%); and their monthly households' income is between € 1001 and € 2500 (42.6%) reflects the profile of those.

As previously mentioned, there is an association between demographic features of investors with their behavioral bias and their financial literacy level. Indeed, to have a broad point of view, we will measure the strength of this association by observing the

relationship between those variables through the correlation matrix. The correlation matrix can be observed in **(Table 4)** and **(Table 5)**.

We have separated the correlation matrix into two tables, since, our data have two kinds of variables. First, we have continuous variables, for example, Age and Income. For that reason, we applied Pearson correlation. On the other hand, we have transformed some of the variables into Binary variables that take 1 if a certain condition were satisfied and 0 otherwise. For instance, the loss aversion variable has been transformed into (1) if the decision maker has the latter behavioral bias, and (0) if not. Based on that, we will apply Tetrachoric Correlation (TC) that is applied on binary data. TC will estimate based on continuous scales the correlation Coefficient.

As we observe in **(Table 4)**, approximately, the correlation coefficient among all the variables is statistically significant. There is a positive association between education and financial literacy in the basic level and the Complex level that is statistically significant. In other words, the more educated the person is, the more his/her ability to answer financial literacy question on both levels, basic and complex. In general, the correlation among the variables is considered low since almost all the variables correlation coefficient don't exceed 0.3. And, we have a very high positive association between Complex-FLI and Risk-FLI of 92.9%, with Risk-FLI representing the interaction between risk perception and Complex FLI questions.

Looking at the figures in **(Table 5)**, we notice a Low negative relationship between Loss aversion and experience, which could lead to prevalence of loss aversion bias in people who are considered less experienced. Males seem to have a higher chance of possessing Ostrich's effect and disposition effect; and a lower chance of having Loss aversion bias. In sum, we can conclude that the variables used in **(Table 4)** and **(Table 5)** have no highly significant correlation coefficients, otherwise, it could lead to multicollinearity problems in the regression that will be used for Hypothesis testing.

In addition to correlation matrix, and, since the models we are trying to build will take into account several variables, then we will apply a direct test for multicollinearity - Variance Inflation Factor (VIF), which is equivalent to the overall model variance that detect highly collinear relationship among the variables. A common rule of thumb state

that a score of 10 or more for VIF gives an evidence on multicollinearity. According to the figures in **(Table 6),** we observe that there is no VIF scores that lead to critical levels of multicollinear relationship.

5. BEHAVIORAL BIAS AND FINANCIAL LITERACY RESULTS

Our first Hypothesis will verify if an Individual's characteristics like Educational level; Experience; Risk perception; Income; Financial literacy; Gender; and age impact Loss Aversion, Gambler's Fallacy, Disposition Effect, and Ostrich's Effect. Based on the literature, different ages and gender have differences in disposition effect bias (Talpsepp, 2010) and loss aversion bias is more prevalent in experienced individuals (Gupta & Ahmed, 2016). For that reason, we will perform a bivariate comparison of mean analysis. We have used a mean comparison test (t-test) for variables that contain two categories. For instance, gender contains males and females. While we performed ANOVA with robust variance test on variables that contain more than two categories, such as Income. The latter analysis will help us to determine if there is an actual difference in the level of behavioral bias among demographics, as well as, among financial literacy levels measured by three Indices (Simple-FLI), (Complex-FLI), and (Self-FLI). The complete results can be observed in **(Table I).**

(Table I) takes into account the mean comparison level between the behavioral bias of the decision-maker with their demographic features and their corresponding financial literacy levels. Experience almost does not have any significant impact on behavioral biases for investors, all other variables appear to have a statistically positive significant impact.

Investors who tend to hold their loosing investments "Disposition effect (loss)" are, in fact, more financially literate. At the same time, investors who tend to sell their appreciated investments "Disposition effect (Gains)" are less financially literate. In terms of Gender, Females appear to be more related to the disposition effect (54.5 Points) than men, which is consistent with previous studies in the literature (Rau, 2014). In general, the lower the levels in loss aversion, gambler fallacy, and disposition effect (Gains) the higher the bands of income with its peak of more than € 4001 per month (19.13, 37.3, and 47.8 points respectively). Also, people who earn between € 501 and € 1000 have more chance of (4.8 Points) being prone to ostrich's effect behavioral biases.

Bearing in mind that our second hypothesis, **(H2)** will determine if different financial literacy levels can mitigate the presence of behavioral biases, such as loss aversion. According to the outcomes, the more financially literate have less chance to be prone to loss aversion, consistent with the previous results found in the literature (Ateşa et al., 2016). Moreover, when people tend to rate themselves as highly knowledgeable (Self FLI), they have less chance (15.7 Points) to possess loss aversion behavioral bias. We find it interesting to note that even people who think to be knowledgeable (Self FLI) have a higher chance to be prone to deposition effect (Gains) biases, and a lower chance to be prone to ostrich's effect.

Lastly, for our third hypothesis **(H3)**, we found that risk can play a major role in differentiating behavioral biases levels among investors. The figures are coherent with the concept of loss aversion, as more risk-averse decision-makers seem to be prone to this phycological bias by (41.6 Points). Also, risk seekers seem to have less chance (34.1 Points) to have the disposition effect (Gains), and more likely (79.3 Points) to incur disposition effect (Loss). This could be linked to prospect theory. In addition, people who consider themselves as risk-averse seems to incur less chances to be prone to ostrich's effect.

Table I: Bivariate Analysis - Mean Comparison of level of Behavioral Bias

Hypothesis **H1, H2 and H3**						
Bivariate Analysis (t-test)	N	**Loss aversion**	**Gambler Fallacy**	**Disposition effect (loss)**	**Disposition effect (Gains)**	**Ostrich's effect**
Gender						
Male	1,867	0.19497	0.42314	0.64381	0.44938	0.02678
Females	444	0.31081	0.41667	0.47297	0.54505	0.02477
Test Value (t)		5.3513***	-0.24810	-6.69800	3.6399***	-0.23690
Std. Error Difference		0.00858	0.01028	0.01014	0.01038	0.00334
Experience						
Test Value (t)		-1.73430	0.73820	-21.723**	-0.33990	-5.04100
Bivariate Analysis (ANOVA)						
Age						
Test Value (t)	2,261	2.9968***	9.2814***	4.20549***	8.63006***	3.61368***
Income						
Income< €500	90	0.24444	0.37778	0.6	0.53333	0.03333

(€501<Income<=€1000)	184	0.28261	0.41848	0.65217	0.51630	0.04891
(€1001<Income<=€2500)	673	0.26003	0.40119	0.74889	0.48440	0.03863
(€2501<Income<=€4000)	447	0.21029	0.46980	0.76734	0.46085	0.03132
(Income> €4001)	230	0.19130	0.37826	0.77391	0.47826	0.03913
Test Value (t)		8.820***	5.2196***	13.3859***	0.7518	1.2105
Educational Level						
Secondary education	536	0.24254	0.44030	0.58955	0.52799	0.02239
Higher education	1,005	0.21891	0.41493	0.62388	0.45871	0.02886
Master's / MBA / PhD	573	0.17627	0.41710	0.66143	0.39965	0.02269
Test Value (t)		9.6512***	16.213***	13.8343***	31.2878***	4.3952***
Risk Perception						
Risk averse	444	0.41667	0.45946	0.66216	0.63964	0.02928
Risk Neutral	440	0.15682	0.41591	0.81136	0.41364	0.04545
Risk Seeker	601	0.07987	0.39434	0.79534	0.34110	0.04326
Test Value (t)		244.35***	4.0717***	50.034***	48.241***	7.5247***
Self-FLI						
More knowledgeable	342	0.28655	0.40643	0.50292	0.51754	0.02339
Average knowledgeable	954	0.24319	0.43816	0.61950	0.49057	0.03459
Less knowledgeable	648	0.15741	0.40278	0.69444	0.43056	0.02623
Test Value (t)		32.893***	2.1353**	19.8747***	16.4478***	8.0225***
Simple-FLI						
Below Average	729	0.31388	0.4479	0.5820	0.5852	0.0221
Above Average	1,425	0.19368	0.4091	0.6989	0.4575	0.0323
Test Value (t)		42.708***	23.858***	27.411***	5.499***	4.124***
Complex-FLI						
Below Average	523	0.30170	0.40875	0.7007	0.5133	0.04136
Above Average	1145	0.21576	0.3977	0.7335	0.4821	0.02626
Test Value (t)		16.140***	8.7609***	11.601***	36.433***	4.532***

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

To test our first two Hypotheses, we will perform a multinomial logit regression model to be able to test the relationship among the variables. The complete results can be observed in Table II, and the model is described by Equation **(1)** below.

$$(\mathbf{1})\ Behavioral\ Bias^{1} = \alpha + \beta 1\ Simple\ FLI + \beta 2\ Complex\ FLI + \beta 3\ Age + \beta 4\ Males + \beta 5\ Income + \beta 6\ Educational\ Level + \beta 7\ Risk\ Perception + \beta 8\ Experience + \epsilon^{2}$$

The empirical estimates in **(Table II)** Indicate that Age; Educational Level; Risk perception; and advanced financial knowledge have an impact on loss aversion behavioral bias. Noting that only Age and educational level increases the odds to have a higher loss aversion level. We can observe that older people have a tendency to incur loss aversion more than young people, which is consistent with previous literature (Gächter et al., 2021). We notice that people who consider themselves as risk seekers are the ones who are less prone to loss aversion bias. This latter result confirms with literature since when individuals incur loss aversion, they overweight losses relative to gains (Tversky & Kahneman, 1991). By doing this, investor tend to be extreme fearful and irrationally expose a risk-averse behavior. On the other hand, the relationship between risk-tolerance and loss aversion could depend on the wealth status for investors. For instance, previous literature, such as Ngoc (2013) reveals that investors become risk-seekers when faced with gains and risk-averse in the case of losses.

Moreover, the selected variables that have been chosen to perform this study seem to not have any impact on gambler fallacy bias. Thus, this could confirm with the literature that the disadvantages of previous studies on gambler fallacy behavioral bias, is that almost all previous researchers were performed to audience and participants in casinos and lotteries applications, and, not to a random sample from the population. Thus, it's based on self-selected participants and doesn't represent the general population (Suetens & Tyran, 2011). In our case, the sample was selected randomly and could lead to a general population since the results observed are consistent with previous studies and rational logic.

As mentioned before, we have divided the disposition effect into two parts - Disposition effect (loss) and disposition effect (gains). We found that investors who hold their depreciated stocks "disposition effect (Loss)" associated with factors such as Age;

[1] Our dependent variable will be the four behavioral biases we have: Loss Aversion, Gambler's Fallacy, Disposition Effect (Loss), Disposition Effect (Gains), and Ostrich's effect.
[2] Variables defined in Table 2.

Income; Risk perception; Simple financial knowledge; and Experience. Having an income in the upper class and exhibiting a risk-seeking behavior increases the chance of holding your loosing investment. Still, older people incur disposition effect (Loss) less than young people.

While, Investors who sell early their appreciated stocks "Disposition effect (Gains)" are impacted by factors such as Gender; Age; Educational Level; Advanced financial knowledge; and Risk perception. We find that older people have more chances to incur disposition effect when they sell their "winner" in line with previous studies (G. Chen et al., 2007). In terms of gender, females are more prone to this behavioral bias. This latter result was exposed by Rau (2014). Experience positively increases the odds to have a disposition effect (Loss).

In extant literature, the disposition effect can indeed explain prospect theory. Prospect theory, by definition, has its value function concave for gain and convex for losses, implying a risk-averse behavior towards gains and risk-seeking towards losses (Kahneman & Tversky, 1979). Observing the figures below in **(Table II)**, we found a statistically significant risk-seeking behavior towards disposition effect in terms of losses and risk-averse behavior towards potential gains. This could confirm with previous literature that concluded "Prospect theory can indeed explain ex-post disposition behavior but not ex-ante disposition behavior" (Hens & Vlcek, 2011, p.153).

Lastly, demographical features such as Age; Gender; and educational level seem to decrease the odds of having ostrich's effect. Males are less prone to ostrich's effect than females. In other words, Males, by (61.1%)[3], are less likely to incur ostrich's effect than females. And, as educational background increases, the decision-maker has less chance (53.6%) to monitor more frequently when the market conditions are booming and less frequently when markets are economically in a deteriorating situation. In addition, younger people incur ostrich's effect more than older people.

[3] Figures such as this in the text represent the percentage increase or decrease the dependent variable will be affected if the independent variable increase or decrease. In our example, Males have a 61.1% chance to incur ostrich's effect.

Table II: Multinomial Logit Regression for Behavioral biases Indices

Variables	**Loss aversion**	**Gambler Fallacy**	**Disposition effect (loss)**	**Disposition effect (gains)**	**Ostrich's effect**
	Estimate	Estimate	Estimate	Estimate	Estimate
	(Std. Error)	(Std. Error)	(Std. Error)	(Std. Error)	(Std. Error)
Simple-FLI	-0.093	-0.024	0.154**	-0.072	0.266
	(0.072)	(0.055)	(0.06)	(0.059)	(0.196)
Complex-FLI	-0.114*	0.051	0.08	-0.137***	0.123
	(0.067)	(0.051)	(0.056)	(0.053)	(0.129)
Age	0.01**	0.005	-0.018***	0.024***	-0.013*
	(0.005)	(0.004)	(0.004)	(0.004)	(0.007)
Males	-0.266	-0.065	-0.014	-0.361**	-0.611*
	(0.173)	(0.133)	(0.165)	(0.152)	(0.369)
Income	0.018	-0.002	0.135**	0.041	-0.115
	(0.068)	(0.054)	(0.062)	(0.056)	(0.134)
Educational Level	0.134**	-0.068	0.019	0.079*	-0.536***
	(0.059)	(0.048)	(0.05)	(0.045)	(0.101)
Risk Perception	-0.913***	-0.066	0.284***	-0.461***	0.194
	(0.075)	(0.052)	(0.062)	(0.055)	(0.122)
Experience	0.319	0.102	0.651***	-0.041	0.176
	(0.25)	(0.193)	(0.197)	(0.196)	(0.418)
Observations	2311	2311	2311	2311	2311
Wald Test	0,0000	0,0000	0,0000	0,0000	0,0000

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

As previously stated, the level of financial literacy can impact behavioral biases. This impact can be directly positive or negative. In the case of a positive association, then the behavioral bias will be more likely to occur in more financially literate individuals, and,

in the case of a negative association, then financial literacy will play a role in mitigating the occurrence of the behavioral bias.

In order to have a broad view of the latter impact, we decided to observe the relationship between financial literacy and behavioral biases from two perspectives. First, we want to observe the Effective impact of financial literacy measured by Classical measures (Complex-FLI and Simple-FLI). The second one is the Subjective financial knowledge that takes into account self-assessed individual evaluation measured by (Self FLI); 'Nothing Knowledgeable' (1) to 'Very Knowledgeable' (5). By doing this, we can distinguish between what people actually know and what they believe they know. This difference could lead to a fundamental change in terms of the relationship between financial literacy levels in decision-makers and their corresponding behavioral bias.

To study the direct impact of Effective financial literacy on behavioral biases and whether financial literacy can mitigate the occurrence of behavioral biases in individuals that are financially literate, we perform the previous multinomial logit Regression model in equation **(1)** above.

According to the outcomes in **(Table II)**, we found that financial knowledge measured by (Simple-FLI) and (Complex-FLI) has no statistically significant impact on Gambler Fallacy and Ostrich's effect physiological biases. We observe that people who are more effectively financially literate possess less (11.4%) chance to be prone to loss aversion. This result is consistent with the bivariate analysis done in **(Table I)** since we have seen that people who are above average in terms of financial knowledge are less likely to be deceived in their decision-making process and be exposed to loss aversion bias. This negative association was argued by previous literature (Ateşa et al., 2016). In sum, we can conclude that financial literacy actually can mitigate loss aversion behavioral bias.

On the other hand, dividing disposition effect into two elements (Gain and Loss) have shown a broad point of view to us, since, we can observe the relationship among the variable of interest from two perspectives: the risk-averse behavior towards gains and risk-seeking towards losses. Consequently, we notice that the concave side for gain is negatively associated with effective Simple financial literacy measures. Also, effective Complex financial knowledge increases the odds for the convex side of losses. In other

words, there is less chance (13.7%) for investors who are more financially knowledgeable to sell their "winning" investments. And, there is more chance of (15.4%) for decision-makers who are more knowledgeable in terms of Simple confidence to hold their "loosing" investments. The latter results are aligned with the bivariate analysis done in **(Table I)**, where disposition effect (gains) is more prevalent in people who are considered below average (less financially literate), and, disposition effect (losses) is more prevalent in people who are considered above average (more financially literate).

To study the direct impact of Subjective financial literacy on behavioral biases and whether financial literacy can mitigate behavioral biases in financially literate individuals, we perform a multinomial logit Regression model in equation **(1)**. However, we used self-assessed financial literacy measure, rather than standard classical measures (Simple-FLI and Complex-FLI).

Subjective literacy measured in this paper takes into account a Self-evaluation question, where the participant can rank themselves in relation to "knowledge" according to their beliefs. This could contribute more to the outcomes of this paper, since we can observe the relationship between financial literacy and behavioral biases from the perspective of individuals who consider themselves as knowledgeable, but they are not necessarily financially literate, thus proxying for (literacy) self-confidence.

According to the results shown in **(Table III)**, we observe that Self-evaluation index cannot explain Loss aversion, Gambler Fallacy and Disposition effect (losses) since the relationship is not statistically significant. Indeed, our variable of interest (Self-FLI) impact both Disposition effect (Gains) and Ostrich's effect. Interestingly, there is a positive association among people who consider themselves knowledgeable and Disposition effect (Gains), as the more financially knowledgeable people think they are, the more they are prone to sell their appreciated investments.

On the other hand, the people who consider themselves more financially knowledgeable are in fact less likely to incur ostrich's effect. This could show that potentially overconfident individuals don't avoid physiological discomfort by evading exposure to negative information. Instead, their monitoring frequency for their investments is constant regardless of the economic conditions.

The above results can illustrate a significant impact, since we can compare effective financial literacy and Subjective financial literacy. As a comparison among the mutual significant dependent variable that can be explained by (Simple FLI), (Complex FLI) and (Self FLI) is the Disposition effect (Gains). Consequently, financially knowledgeable people can mitigate the occurrence of disposition effect (gains). While, people who think they are knowledgeable are more prevalent to possess the disposition effect (Gains). This result might point to potential overconfidence.

Contrary to our expectation, there is no standing one-way relationship between financial literacy and behavioral bias. Financial literacy (subjective or Effective) can indeed mitigate the prevalence of some of the behavioral studied above, however, financial literacy could lead in the opposite direction. Extant literature (Collins & O'Rourke, 2010, P.483) illustrated that "consumers face more than informational barriers when they make financial decisions. For instance, consumers may lack self-control or exhibit other behavioral biases that education and counseling may not enable them to overcome". Also, Campbell, Jackson & Madrian (2011) argue that if individuals are learning through trial and error, the deficiency of financial knowledge should not cause a problematic situation.

Table III: Multinomial Logit Regression for Behavioral Biases using Self-assessed Literacy

Variables	**Loss aversion**	**Gambler Fallacy**	**Disposition effect (loss)**	**Disposition effect (gains)**	**Ostrich's effect**
	Estimate	Estimate	Estimate	Estimate	Estimate
	(Std. Error)	(Std. Error)	(Std. Error)	(Std. Error)	(Std. Error)
Self FLI	0.017	0.054	0.016	0.151**	-0.361***
	(0.071)	(0.057)	(0.068)	(0.059)	(0.117)
Age	0.013***	0.004	-0.021***	0.025***	-0.015**
	(0.004)	(0.003)	(0.004)	(0.004)	(0.008)
Males	-0.317*	-0.03	0.045	-0.43***	-0.652**
	(0.171)	(0.145)	(0.162)	(0.151)	(0.322)

Income	-0.013	0.004	0.155**	0.009	-0.018
	(0.067)	(0.054)	(0.062)	(0.055)	(0.134)
Educational Level	0.127**	-0.106**	-0.001	0.026	-0.356***
	(0.062)	(0.048)	(0.054)	(0.048)	(0.112)
Risk Perception	-0.923***	-0.074	0.294***	-0.506***	0.373***
	(0.076)	(0.053)	(0.064)	(0.057)	(0.143)
Experience	0.3	0.084	0.678***	-0.076	0.403
	(0.246)	(0.187)	(0.196)	(0.197)	(0.429)
Observations	2311	2311	2311	2311	2311
Wald Test	0,0000	0,0000	0,0000	0,0000	0,0000

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

To test our last hypothesis **(H3)**, we wanted to introduce the marginal effect of financial literacy considering its interaction with risk perception. This interaction will illustrate people's risk attitude, at the same time, their corresponding financial literacy levels. Risk attitude bears an important role in investment choices for a household's financial goals such as retirement. Also, it contributes to asset allocation planning, investment choices, and portfolio strategies. Individual risk-tolerance is considered as a part of "risk management" or insurance choices. As such, it plays a major role in optimal portfolio decision-making. However, instead of observing the linear relationship between risk and behavioral biases, we will observe the effect of both risk perception and financial literacy interacting. Extant literature (Bannier & Neubert, 2016) has proven that more financially knowledgeable individuals exhibit more risk-tolerant behavior than less financially literate Individuals. However, will this interaction be linked to behavioral bias? The latter question will be answered through hypothesis **(H3)**.

Based on that, we have introduced a new variable into our sample (Risk FLI), which is generated through the interaction between risk perception and complex financial literacy questions (bonds, risk diversification, and guaranteed capital). In sum, we would observe the direct impact of the interaction between risk perception and financial literacy on their relationship with behavioral biases.

To study whether the moderating Impact of the interaction between Risk perception and financial literacy will influence the relationship between financial literacy and behavioral biases, we perform a multinomial logit Regression model in equation **(2)**.

$$(\mathbf{2})\ Behavioral\ Bias^{4} = \alpha + \beta 1\ Simple\ FLI + \beta 2\ Complex\ FLI + \beta 3\ \text{Risk FLI} + \beta 4\ Age + \beta 5\ Males + \beta 6\ Income + \beta 7\ Educational\ Level + \beta 8\ Risk\ Perception + \beta 9\ Experience + \epsilon^{5}$$

According to the results shown in **(Table IV)**, the outcomes below are consistent with the figures illustrated in **(Table II)**. We can argue that there is no statistically significant impact for our variable of interest (Risk-FLI) with Gambler Fallacy, Disposition effect (loss), Disposition effect (Gains), and Ostrich's effect.

We observe that (Risk-FLI) can indeed explain Loss aversion behavioral biases. In fact, the more financially literate people are, then the less chance to be prone to loss aversion (45%). While the more risk-tolerant people are, the less to incur loss aversion (96.6%). However, these latter result reveals only a linear relationship between our variable of interest. Indeed, we can observe that there is a negative association between the interaction of risk perception and financial literacy with loss aversion behavioral bias. Thus, we can say that if people were less financially literate, at the same time, more risk-averse, then they are more willing to exhibit loss aversion bias.

In sum, interaction between risk perception and financial knowledge can only explain loss aversion behavioral bias in the sample. Consequently, the more risk-tolerant and more financially literate the person is, the less chance to incur loss aversion bias. We conclude that Risk interaction can play a moderating role in terms of the relationship between behavioral biases and financial literacy.

[4] Our dependent variable will be the four behavioral biases we have: Loss Aversion, Gambler's Fallacy, Disposition Effect (Loss), Disposition Effect (Gains), and Ostrich's effect.
[5] Variables defined in Table 2.

Table IV: Multinomial Logit Regression for Risk Interaction on Behavioral Bias

Variables	**Loss aversion**	**Gambler Fallacy**	**Disposition effect (loss)**	**Disposition effect (gains)**	**Ostrich's effect**
	Estimate	Estimate	Estimate	Estimate	Estimate
	(Std. Error)	(Std. Error)	(Std. Error)	(Std. Error)	(Std. Error)
Simple-FLI	-0.104	-0.022	0.154**	-0.072	0.269
	(0.068)	(0.055)	(0.06)	(0.059)	(0.197)
Complex-FLI	-0.45***	0.009	0.063	-0.125	0.038
	(0.15)	(0.13)	(0.145)	(0.141)	(0.311)
Risk-FLI	-0.238***	0.015	0.007	-0.004	0.028
	(0.058)	(0.043)	(0.05)	(0.048)	(0.1)
Age	0.012***	0.004	-0.018***	0.024***	-0.014*
	(0.004)	(0.003)	(0.004)	(0.004)	(0.007)
Males	-0.277	-0.019	-0.013	-0.361**	-0.612*
	(0.17)	(0.147)	(0.164)	(0.152)	(0.37)
Income	0.011	0.003	0.135**	0.041	-0.114
	(0.067)	(0.054)	(0.062)	(0.056)	(0.133)
Educational Level	0.159***	-0.079	0.019	0.079*	-0.536***
	(0.058)	(0.044)	(0.05)	(0.045)	(0.101)
Risk Perception	-0.966***	-0.072	0.285***	-0.461***	0.193
	(0.077)	(0.051)	(0.063)	(0.055)	(0.122)
Experience	0.289	0.101	0.651***	-0.041	0.18
	(0.243)	(0.19)	(0.197)	(0.196)	(0.419)
Observations	2311	2311	2311	2311	2311
Wald Test	0,0000	0,0000	0,0000	0,0000	0,0000

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

6. DISCUSSION OF RESULTS

We summarize in **(Table V)** the main drivers that affect behavioral biases studied in this paper. We show that risk-lovers have a lower chance to possess loss aversion, and, highly educated individuals are more prone to loss aversion. We can observe that older people have a tendency to incur loss aversion more than young people, which is consistent with previous literature (Gächter et al., 2021). For Gambler fallacy, the results reveal a non-significant relationship among any of the independent variable chosen for this paper.

We show that being a risk-seeker; more experienced and earning a higher level of monthly income increases the chances to incur disposition effect (Loss), but age negatively associate with disposition effect (Loss). Also, disposition effect (Gains) negatively associated with risk perception and Gender. Females have a higher chance to sell their "winners" than males. This latter result was exposed by Rau (2014). Older people have more chances to incur disposition effect when they sell their "winner" which previous studies have demonstrated (G. Chen et al., 2007), and highly educated people are more exposed to disposition effect (Gains). We observe that being old; male; and highly educated decreases the odds to incur ostrich's effect.

Table V: Main Drivers of Behavioral Bias

	Loss Aversion	Gambler's Fallacy	Disposition Effect (Losses)	Disposition Effect (Gains)	Ostrich's Effect
Age	Positively	-	Negatively	Positively	Negatively
Males	-	-	-	Negatively	Negatively
Income	-	-	Positively	-	-
Educational Level	Positively	-	-	Positively	Negatively
Risk Perception	Negatively	-	Positively	Negatively	-
Experience	-	-	Positively	-	-

Also, **(Table V)** summarizes the direct effect of financial literacy on the four behavioral biases chosen for this study. Effective financial literacy can mitigate loss aversion, in line with previous literature (Ateşa et al., 2016). We found that financial knowledgeable individuals are less likely to incur Disposition effect (Gain), but more likely to incur disposition effect (Loss). In contrast, Subjective financial literacy increases the odds to incur disposition effect (Gains), and negatively associate (mitigate) with ostrich's effect.

Table VI: Relationship Between Financial Literacy and Behavioral Bias.

	Effective Financial literacy	**Subjective financial literacy**
Loss Aversion	Negative (Mitigate)	No Significant Impact
Gambler Fallacy	No Significant Impact	No Significant Impact
Disposition Effect (Loss)	Positive	No Significant Impact
Disposition Effect (Gains)	Negative (Mitigate)	Positive
Ostrich's effect	No Significant Impact	Negative (Mitigate)

The above results matter for several reasons. First, individual investors can increase their self-awareness regarding behavioral biases, thus they can avoid certain biases on themselves. Second, regulators can consider this information valuable when they impose regulations. Lastly, Policy makers can design financial literacy programs that target specific characteristics.

7. CONCLUSION

The aim of this paper is to analyze the main drivers of the four behavioral biases: Loss Aversion, Gambler's Fallacy, Disposition Effect, and Ostrich's Effect. We analyze whether the increase of financial literacy levels can mitigate cognitive biases of individuals in the Portuguese market. We tested the impact of financial literacy on behavioral biases on the basis of two categories: Effective literacy measured by classical measures; and Subjective Literacy. Consequently, we can distinguish between what decision-makers actually know (Effective) and what they think they know (Self assessed). We believe that this analysis is important since it could lead to a more efficient financial behavior in the Portuguese market. Additionally, we contribute to whether this efficiency can be achieved through financial-knowledge programs to improve the levels of financial literacy or by a more complex program regarding additional targeting characteristics.

Related to behavioral biases, the finding was consistent with the previous literature, where older people have a tendency to incur loss aversion more than young people (Gächter et al., 2021). Also, the results reveal that Risk perception impact negatively Loss aversion, and factors such as educational Level increases the odds to be prone to loss aversion.

We found that being older; male; and highly educated decreases the odds of having the ostrich's effect. Moreover, the selected variables that have been chosen to perform this study seem not to have any impact on the gambler fallacy bias. The latter results could confirm with the literature that the disadvantages of previous studies on gambler fallacy behavioral bias, is that almost all previous researchers were performed to audience and participants in casinos and lotteries applications, and, not to a sample from a random population like our sample, thus explaining their evidence.

Regarding disposition effect; Age is negatively associated with disposition effect (loss), and, Income, Risk perception, and Experience increase the odds of holding your "loosing" investment. On the other hand, disposition effect (Gains) is affected positively by Age and education levels. Older people have more chances to incur disposition effect when they sell their "winner" in line with previous studies (G. Chen et al., 2007). We found that females are more prone to this behavioral bias. This latter result was exposed by Rau (2014), and risk-averse have more chance to be prone to disposition effect (Gains).

In addition, we found that the disposition effect can indeed explain prospect theory. Prospect theory, by definition, has its value function concave for gain and convex for losses, implying a risk-averse behavior towards gains and risk-seeking towards losses (Kahneman & Tversky, 1979). Through our analysis, we notice a statistically significant risk-seeking behavior towards disposition effect in terms of losses and risk-averse behavior towards potential gains. This result confirms previous literature (Hens & Vlcek, 2011).

Contrary to our expectation, there is no standing one-way relationship between financial literacy and behavioral bias. Financial literacy (subjective or Effective) can indeed mitigate the prevalence of some of the behaviors studied. However, financial literacy could lead to the opposite side direction. We find a significant relationship between the effective level of financial knowledge and the loss aversion, Disposition effect (Gains), and Disposition effect (Loss). This relationship is negative for disposition effect (Gains) and positive for disposition effect (Losses). Thus, effective financial literacy can indeed mitigate loss aversion bias. This negative association was exposed by previous literature (Ateşa et al., 2016). Additionally, effective financial literacy can

mitigate the tendency of people to sell their appreciated investments (Disposition effect for Gains).

On the other hand, we found that subjective financial literacy, measured by self-assessed questions, can be explained by the disposition effect (Gains) and Ostrich's effect. people who consider themselves more financially knowledgeable are in fact less likely to incur ostrich's effect. Consequently, our main finding is that people who actually are financially knowledgeable can mitigate the occurrence of disposition effect (gains). While people who think they are knowledgeable (overconfident in terms of their literacy) are actually more prevalent to possess the disposition effect (Gains). These results could suggest further studies to test if overconfidence bias could be found in the Portuguese market.

The above mixed results regarding financial literacy (Effective and Subjective) could reveal more undiscovered factors that could influence the level of behavioral biases. Thus, further research is needed. Our results can clearly show that the effort to enhance financial literacy levels among individuals can't solely eliminate behavioral biases. However, a well-informed educational financial program should be designed accordingly.

In relation to Risk interaction, we found that the moderating impact of the interaction between Risk perception and financial literacy could influence the relationship between financial literacy and behavioral biases. We observe that this factor cannot explain Gambler fallacy, Deposition effect (Gains), Disposition effect (loss) and ostrich's effect. However, there is a negative association between the Risk interaction (Risk-FLI) with Loss aversion bias. Based on that, we can say that if people were less financially literate, at the same time, more-risk averse, then they are more willing to exhibit loss aversion.

Finally, in future venues of research, there are several aspects that could be taken into consideration such as financial competence, financial awareness, financial knowledge, and financial capabilities (Miller , Reichelstein, Salas & Zia, 2014). We have focused on financial literacy in our study to observe its direct effect on behavioral biases. In addition, our study focuses only on financial knowledge, which is one of the components of financial literacy. Other areas or components for future research would be financial attitudes and skills.

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APPENDICES

Table 1: Financial Literacy – Answers to Questions (%)

	Numeracy	Inflation	Risk Diversification	Bond	Guaranteed Capital
Incorrect	701	95	861	166	1048
	30.3%	4.1%	37.3%	7.2%	45.3%
Don't Know	145	152	268	261	623
	6.3%	6.6%	11.6%	11.3%	27.0%
Correct	1465	2064	1182	1884	640
	63.4%	89.3%	51.1%	81.5%	27.7%

Table 2: Variables Construction

Variable/Construct	Question
	Behavioral Bias
Loss Aversion	**Your account manager / financial advisor suggests that you invest part of your savings in a financial product that, just as likely, allows you to earn € 80 or lose € 50. Which of the following would you choose?** (1. Invest part of the savings in this financial product which, with equal probability, allows you to earn € 80 or lose € 50. 2. Do not invest in this financial product, as I did not understand the consequences of it well. 3. Do not invest in this financial product, as it has the possibility of losing money. 4. Do not invest in this financial product, as it is very risky.)
Gambler's Fallacy	**Suppose you throw a 'coin in the air' 10 times. If 'crowns' always come out in the first 9 releases, what is the probability of 'crowns' in the 10th release?** (% [0: WRONG ANSWER; 1: RIGHT ANSWER])

Disposition effect (Losses)	**Suppose you made an investment in a financial product with a risk of capital loss. At the end of 1 year, that investment shows losses compared to the capital invested. You now have two options:** **Option A: Keep the investment for another year. At the end of that year, you may experience capital gains or losses.** **Option B: Settle the investment now and receive the capital that remains after the loss. What is your choice?** (1. Option A: Keep the investment for another year. At the end of that year, you may experience capital gains or losses. 2. Option B: Settle the investment now and receive the capital that remains after the loss.)
Disposition effect (Gains)	**Suppose you made an investment in a financial product with a risk of capital loss. At the end of 1 year, that investment shows gains compared to the capital invested. You now have two options:** **Option A: Keep the investment for another year. At the end of that year, you may experience capital gains or losses.** **Option B: Settle the investment now and receive the earnings. What is your choice?** (1. Option A: Keep the investment for another year. At the end of that year, you may experience capital gains or losses. 2. Option B: Settle the investment now and receive the earnings.)
Ostrich's effect (Negative News)	**How often do you consult your investment portfolio: When the market is on negative ground / falling?** (1. Rarely 2. Little 3. Neither too little nor too much 4. A lot 5. Almost always)
Ostrich's effect (Positive News)	**How often do you consult your investment portfolio: When the market is on positive / growing ground?** (1. Rarely 2. Little 3. Neither too little nor too much 4. A lot 5. Almost always)
	Financial literacy
Numeracy	**Suppose you have € 100 in a bank account with an interest rate of 1% per year. After 5 years, how much will the account balance be if you do not withdraw any money from it, and there are no commissions or associated taxes (that is, at the end of each year, let the interest amount stay in that same bank account)?** "1. More than € 105 2. Exactly € 105 3. Less than € 105 "

Inflation	**Suppose you have € 100 in a bank account with an interest rate of 1% per year and inflation is 2% per year. A year from now, what do you think you would be able to buy with the money from that account?** "1. I would buy more things than today. 2. I would buy exactly the same things as today. 3. Buy less stuff than today. 4. It depends on what you would buy "
Bonds	**It invested in a bond that pays a fixed interest rate. Meanwhile, market interest rates have declined. If you sell that bond after this decrease, the price of that bond should be.** "1. Less than the price at which you bought it. Same as the price at which you bought it 3. Higher than the price you bought it "
Risk Diversification	**In your opinion, please indicate whether the following statement is true or false: Investing in a company's stock usually provides a safer return than investing in a stock fund.** "1. True 2. False "
Guaranteed Capital	**What does it mean for a security to have guaranteed capital on the maturity date?** 1. I am entitled to receive the money invested, at any time 2. On the due date I always receive the money invested 3. The issuer of the security reimburses the money invested on the maturity date, provided that it has the financial conditions to do so

Table 3: Demographic variables

variables		Number of observations	% of sample
Gender	Male	1867	81.8%
	Female	415	18.2%
Age	< 30 years old	285	12.6%
	31-40 years old	575	25.4%
	41-50 years old	599	26.5%
	51-60 years old	396	17.5%
	> 60 years old	406	18.0%
	Min	3	
	Max	94	
	Mean (Std. Deviation)	46.45334 (14.01406)	
Educational level	no primary education	2	0.1%
	complete primary education	26	1.1%
	completed basic education	154	6.7%
	completed secondary education	536	23.3%
	completed higher education	1005	43.8%
	Master's / MBA / PhD	573	25.0%
Disposition effect (Gains)	Posses	1081	51.4%
	Not Posses	1024	48.6%
	Do Not Reply	206	
Disposition effect (losses)	Posses	1412	72.7%
	Not Posses	529	27.3%
	Do Not Reply	370	16.0%
Gambler's fallacy	Posses	975	42.2%
	Not Posses	1336	57.8%
	Do Not Reply	0	0%
Loss aversion	Posses	502	25.3%
	Not Posses	1482	74.7%
	Do Not Reply	327	14.1%

Ostrich's effect (positive news)	Posses	918	56.5%
	Not Posses	708	43.5%
	Do Not Reply	685	29.6%
Ostrich's effect (negative news)	Posses	675	42.0%
	Not Posses	932	58.0%
	Do Not Reply	704	30.5%
Ostrich's effect	Posses	61	2.6%
	Not Posses	2250	97.4%
	Do Not Reply	0	0.0%
Income Level of Household	Up to € 500	90	5.5%
	Between € 501 and € 1000	184	11.3%
	Between € 1001 and € 2500	673	41.4%
	Between € 2501 and € 4000	447	27.5%
	More than 4000 €	230	14.2%
Investment hold	Demand deposits	1615	14.2%
	Time deposits	1263	11.1%
	Savings/ Treasury certificates	769	6.8%
	Stocks	925	8.1%
	Obligations of companies	351	3.1%
	Commercial paper	36	0.3%
	Investment funds	850	7.5%
	Complex financial products	347	3.1%
	Retirement savings plans	940	8.3%
	Insurance	1134	10.0%
	Credit card	1336	11.7%
	Bank overdraft	408	3.6%
	Mortgage loans or mortgage-backed loans	704	6.2%
	Other credits (ex: personal, car, home credit)	338	3.0%
	Microcredit (for professional / commercial financing)	31	0.3%
	Crowdfunding Investments	181	1.6%
	Investments in Bitcoins, ICOs, and other digital currencies	149	1.3%

Basic FLI	Below Average	729	33.8%
	Average	0	0.0%
	Above average	1425	66.2%
	Min	-4.3	
	Max	0.6	
	Mean (Std. Deviation)	1.40E-08 (1.07)	
Complex FLI	Below Average	523	24.3%
	Average	0	0.0%
	Above average	1145	53.2%
	Min	-3.311468	
	Max	1.352437	
	Mean (Std. Deviation)	-6.14E-09 (1.10)	
Self FLI	Nothing knowledgeable	113	5.0%
	Little knowledgeable	342	15.1%
	Average knowledgeable	954	42.1%
	knowledgeable	648	28.6%
	Very knowledgeable	211	9.3%
	Min	0	
	Max	5	
	Mean (Std. Deviation)	3.1 (1.06)	
Risk Profile Self-Evaluation	Very averse to risk	169	10.0%
	Risk averse	444	26.2%
	Risk Neutral	440	26.0%
	Risk Seeker	601	35.5%
	Really Risk Seeker	38	2.2%
	Min	1	
	Max	5	
	Mean (Std. Deviation)	2.9 (1.05)	

Table 4: Correlation Matrix

	Simple FLI	Complex FLI	RISK FLI	SELF FLI	Age	Income	Risk	Education
Simple-FLI	1							
Complex-FLI	0.28***	1						
RISK-FLI	0.23***	0.9***	1					
SELF-FLI	0.21***	0.31***	0.28***	1				
Age	0.01	(0.12)***	(0.08)***	(0.17)***	1			
Income	0.17***	0.18***	0.15***	0.18***	0.16***	1		
Risk	0.16***	0.18***	0.14***	0.32***	(0.13)***	0.07***	1	
Education	0.21***	0.23***	0.21***	0.27***	(0.25)***	0.22***	0.05**	1

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

Table 5: Correlation Matrix (Binary Variables)

	Males	Experience	Loss Aversion	Gambler's Fallacy	DEL	DEG	Ostrich's effect
Males	1						
Experience	0.26***	1					
Loss Aversion	(0.20)***	0.06*	1				
Gambler's Fallacy	0.009	(0.02)	0.01	1			
DEL (1)	0.24***	0.61***	(0.07)***	0.003	1		
DEG (2)	(0.13)***	0.01	0.58***	0.04	(0.19)***	1	
Ostrich's effect	0.018	0.50***	(0.08)	0.07	0.33***	(0.13)**	1

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

(2): Disposition Effect (Gains);(1): Disposition Effect (Loss)

Table 6: Multicollinearity Test - VIF (variance inflation factor)

Variables	VIF
Complex-FLI	7.71
Simple-FLI	1.18
Self-FLI	1.33
Risk-FLI	7.29
Education	1.29
Age	1.26
DEG*	1.2
Income	1.18
Risk	1.35
Males	1.12

DEL**	1.12
Experience	1.09
Ostrich's effect	1.02
Gambler Fallacy	1.01
Mean VIF	2.08

***DEG: Disposition Effect (Gains); **DEL: Disposition Effect (Loss)**