Lisbon School of Economics & Management
Universidade de Lisboa

MASTER
IN FINANCE

MASTER´S FINAL WORK
DISSERTATION

FINANCIAL LITERACY AND DEMOGRAPHIC CHARACTERISTICS EFFECTS ON CRYPTOCURRENCIES INVESTMENTS – EVIDENCE FROM PORTUGAL

FILIPA CARDOSO DIAS CALDAS FARIA

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SUPERVISION:
PROFESSOR TIAGO CRUZ GONÇALVES

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GLOSSARY

CMVM – Portuguese Stock Exchange Regulator.

COVID-19 – Coronavirus Disease 2019.

ECB – European Central Bank.

FL – Financial Literacy.

ICO – Initial Coin Offering.

IPF – Iterated Principal Factor.

ISEG – Lisbon School of Economics and Management.

NFEC – National Financial Educators Council.

OECD – Organization for Economic Co-operation and Development.

PCA – Principal Component Analysis.

VIF – Variance Inflation Matrix.

ABSTRACT, KEYWORDS AND JEL CODES

The purpose of this work is to analyze the association between individuals' financial literacy and their attitudes towards the cryptocurrency market in Portugal. Using data collected from a survey conducted by CMVM and other financial institutions in 2018, we measure financial literacy categorized into subjective and objective fields. The present study assesses the hypotheses of investors' demographic characteristics and financial literacy levels influencing investments in any type of cryptocurrencies, such as bitcoins, ICOs, etc. The findings indicate that cryptocurrency owners are more likely to be young, male, earn a higher monthly income, and be more risk-tolerant than non-owners. Regarding financial literacy, we do not find any direct association with these investments for this period. Further to a detailed analysis, we state that an increase simultaneously in risk tolerance and financial literacy of individuals enhances their likelihood of cryptocurrency ownership. Moreover, we perform additional analysis on a similar CMVM survey conducted to university students and alumni in 2020, a year characterized by the COVID-19 pandemic. These supplementary results indicate that the average cryptocurrency owner is most likely to be male, have an uncertain labor status, and be more risk-tolerant compared to non-owners. Only subjective financial literacy is positively related to cryptocurrency ownership in the new sample. Overall, demographic characteristics have an influence on cryptocurrency ownership and the subjective field of financial literacy is found to positively impact our dependent variable only in times of financial crisis.

KEYWORDS: Cryptocurrencies; Cryptocurrency ownership; Demographic characteristics; Financial Literacy, Portugal.

JEL CODES: G01; G11; G28; G53; J10; O52.

RESUMO

O objetivo desta dissertação é investigar a associação entre a literacia financeira dos indivíduos e as suas atitudes em relação ao mercado de cripto-moedas em Portugal. Utilizando dados recolhidos de um inquérito conduzido pela CMVM e outras instituições financeiras em 2018, avaliámos a literacia financeira categorizada em subjetiva e objetiva. O presente estudo analisa as hipóteses das características demográficas dos investidores e dos seus níveis de literacia financeira influenciarem investimentos em qualquer tipo de cripto-moedas, tais como bitcoins, ICOs, etc. Os resultados indicam que os investidores de cripto-moedas têm maior probabilidade de ser jovens, homens, auferirem um rendimento mensal mais elevado, e serem mais tolerantes ao risco do que os não investidores. Relativamente à literacia financeira, não encontramos qualquer associação direta com estes investimentos para aquele período. No seguimento de uma análise detalhada, confirmamos que um aumento simultâneo da tolerância ao risco, bem como da literacia financeira dos indivíduos, aumenta a probabilidade dos mesmos investirem em cripto-moedas. Adicionalmente, analisámos um inquérito semelhante da CMVM realizado a estudantes universitários e antigos alunos, em 2020, um ano caracterizado pela pandemia da COVID-19. Estes resultados suplementares indicam que o investidor médio de cripto-moeda é provavelmente masculino, tem um estatuto de trabalho incerto, e é mais tolerante ao risco em comparação com os não investidores. Somente a literacia financeira subjetiva está positivamente relacionada com a posse de cripto-moedas na nova amostra. No geral, as características demográficas influenciam a posse de cripto-moedas e o campo subjetivo da literacia financeira é considerado como tendo um impacto positivo na nossa variável dependente apenas em tempos de crise financeira.

PALAVRAS-CHAVE: Cripto-moedas; Investimentos em cripto-moedas; Características demográficas; Literacia financeira, Portugal.

CLASSIFICAÇÃO JEL: G01; G11; G28; G53; J10; O52.

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1. INTRODUCTION

Individuals have become more actively engaged in financial markets today than ever due to the new financial products and services constantly arising. Along with the exponential technological advance, turbulence in the financial world and consequential economic crisis have led investors to search for new opportunities regarding their financial investments. All these factors enabled the era of cryptocurrencies to emerge. Nevertheless, apart from its many investment opportunities, cryptocurrencies present many risks for investors. Further to its worldwide success and adherence, many individuals might be naively engaged in the cryptocurrency market without completely understanding its consequences. In this way, the volatility and complexity that characterize this market require households to be financially literate.

Financial literacy impacts the daily life of individuals. Its relationship with attitudes towards cryptocurrencies investments is a relevant topic to study due to the lack of prior findings and the increasing attention towards this type of risky investments nowadays. Do cryptocurrency investments associate with the demographic characteristics of the investor? Is the level of financial literacy positively associated with cryptocurrency investments? Still to be answered, these questions characterize the focus of this study.

The aim of this research is to determine the presence of an association between the level of investors' financial literacy with their attitudes towards cryptocurrencies in Portugal and in which way they relate to each other. The importance to answer this subject concerns the possibility that these investors are not financially literate and may perhaps be engaging in risky financial products without realizing how these behave. This issue should constitute a major concern for regulatory entities, since cryptocurrencies are highly volatile assets that may cause investors to suffer large and unexpected losses, particularly in the event of financially illiterate investors.

The database used for this study corresponds to a survey conducted by CMVM (Portuguese Stock Exchange Regulator) in 2018 to Portuguese investors with the purpose of understanding their level of financial literacy, as well as their investor profiles. We find that demographic characteristics, such as gender, age, and income level of investors are associated with these investments, as well as their risk tolerance. On average, cryptocurrency owners tend to be male, younger, more risk-tolerant, and earn a higher

income than non-owners. We find that both the subjective and objective fields of financial literacy are not statistically significant associated with the investments in cryptocurrencies by these specific investors. Furthermore, we conclude that moderated by the level of risk tolerance, the effect of both subjective and objective financial literacy on cryptocurrencies ownership becomes relevant, indicating that an increase in both leads to an increase in the likelihood of cryptocurrency ownership.

In addition, we conduct a supplementary analysis regarding a similar survey conducted in 2020 by Portuguese universities to their students and alumni. We assume that the new sample incorporates the effect of the Covid-19 pandemic, defined as uncertain and financially unstable times, worldwide. Objective financial literacy continues not to be significant to influence these investments. Moreover, the perception of the financial literacy level of individuals is relevant regarding a year characterized by the ascension of a pandemic and, even more, it is positively associated with the ownership of cryptocurrencies. Demographic characteristics like gender and the financial security given by the labor status, as well as risk tolerance, have an impact on cryptocurrency ownership. In 2018, the average cryptocurrency owner is male, has an uncertain labor status and is more risk tolerant compared to non-owners.

Our investigation contributes to the literature since 1) it extends the research question to Portuguese investors, which, further to our knowledge, has not been done before, 2) further to the mixed evidence found in the literature regarding the possible association between financial literacy and attitudes to these investments, we provide new input in this respect, namely by looking at different samples of financial institutions' clients and universities networks and 3) new results taking into account a financial crisis are exposed, leading to new conclusions regarding cryptocurrencies investments in times of financial recession.

This study is organized as follows: in section 2 we review the present literature regarding cryptocurrencies and their relationship with financial literacy level, as well as demographic characteristics and profile of investors. Following section 3, we present our main hypotheses and expected findings. In section 4, we describe our study methodology, which includes data description and construction of the variables of interest, followed by

the employed econometric model (Section 5). Finally, section 6 regards the empirical results of our analysis following our main conclusions with a brief discussion (Section 7).

2. LITERATURE REVIEW

Cryptocurrencies are a very recent phenomena with an increasing number of enthusiastic investors and growing attention from regulators (Almeida and Gonçalves, 2022; Hackethal et al., 2019). Technology innovation along with the media fuss around cryptocurrencies caused its appearance to be a relevant field of study in today's world. Thus, it is critical to understand its definition and purpose. According to CMVM, crypto assets are digital representations of blockchain technology-based assets not issued by a central bank, credit institution, or electronic money institution and may be used as a form of payment in a community that accepts or serves other purposes, such as the assignment of the right to use certain goods and services or to a financial return. To this end, the term "crypto" encompasses the nomenclatures normally associated with it, such as tokens, coins, cryptocurrency, and virtual currency (CMVM).

Following the 2008 subprime crisis, individuals started to lose their trust on traditional banking systems (Jha et al., 2022). Significant transaction costs, personal information hassling, and trust-based services that define the current electronic payments involving financial institutions (Nakamoto, 2008) resulted in the creation of cryptocurrencies that aim to overcome these issues, by transforming trading in a more independent and anonymous way (Fauzi et al., 2020). While many authors defend that cryptocurrency, namely bitcoin, use occurs mainly as a payment transaction system, others sustain that bitcoin is more of a speculative investment (Yermack, 2015) driven by buyers and sellers (Baek et al., 2015) originating possible capital gains (Stix, 2021). Nevertheless, evidence shows that, amongst current and potential investors, both transaction and speculation purposes prevail equally (Stix, 2021).

According to Ankenbrand and Bieri (2018), cryptocurrencies differ from fiat currencies (government-issued currencies), in the sense that they have electronic and digital nature, and its transactions are validated on a peer-to-peer exchange – i.e., from user to user (without the involvement of a centralized authority). In comparison to other asset classes, such as stocks, bonds, commodities, and foreign exchange, the authors argue that cryptocurrencies exhibit much higher volatility compensated by higher returns.

The authors also conclude that there is a potential portfolio diversification by including cryptocurrencies due to the low correlation with the other asset classes, raising the set of optimal portfolios for investors, which is in line with Colombo et al. (2021)' findings. Cryptocurrency market never sleeps, as trading can occur 24 hours a day, 7 days a week, making investors actively and constantly follow price movements, news, and research of the distinct coins, which ends up absorbing a large amount of their time and interfering with day-to-day tasks (Delfabbro et al., 2021).

Launched in 2008, bitcoin is the leading cryptocurrency (ECB, 2012). Bitcoin is the first cryptocurrency that uses blockchain technology (Yilmaz et al., 2018) and it is based on a proof-of-work system. For new blocks (bitcoins) valid action, miners (network members) get a block fraction as a reward and incentive (Ankenbrand and Bieri, 2018). The purpose of the proof-of-work is to replace the role of financial intermediaries. This reward is generated by solving complex problems involving computer power (Delfabbro et al., 2021). In this way, the supply of money depends only on the interested users performing this activity instead of monetary policies of any virtual central bank (ECB, 2012). One particularity is that the number of bitcoins is limited, i.e., it is expected that it will reach 21 million around 2040. From then, miners should finance themselves through transaction fees (ECB, 2012).

According to Yermack (2015), for bitcoin to be classified as a currency, three criteria must be observed: medium of exchange, unit of account, and store of value. Regarding the first requirement, the author defends that only a minority of individuals use bitcoin to purchase goods and services, proving bitcoin's negligible market presence. The reasoning behind this is due to the difficulty of acquiring new bitcoins, which is only possible due to the mining process or through an online exchange. As a unit of account, the extreme volatility of bitcoin constitutes an impossible task for any vendor or customer seeking to establish a reference point for setting consumer prices. In addition, bitcoin's high cost compared to typical products and services is also a negative aspect that leads to declassifying it as a currency. Lastly, in terms of a store of value function, Yermack (2015) concludes that the high-risk factor of bitcoin, as well as its lack of security, confirms that bitcoin is not yet ready to be considered a currency. In accordance, bitcoin was characterized as a crypto asset by the ECB (2021).

Cryptocurrencies' future appears attractive to many, as a lot of investors have started to include them in their portfolios (Yilmaz et al., 2018). Network and technology safety, low costs of transaction, and high investment returns (Fauzi et al., 2020) are the most referred opportunities arising from this technology. Since the blockchain mechanism intends to expertly perform the transactions under anonymous conditions, the profile and private information of the investors remain unreleased, unlike how banks and other institutions operate. Apart from providing confidentiality services, under very complex cryptography, cryptocurrencies algorithm is defended to be safer than using credit cards (Fauzi et al., 2020). Meeting its purpose, bitcoin and other cryptocurrencies' transaction costs are lower compared to others in the sense that the only requirement to transact and trade bitcoins is to have access to the internet (Fauzi et al., 2020). Moreover, returns-wise, due to its scarcity and increase in demand, bitcoin price is most likely to increase, generating positive and high returns (Fauzi et al., 2020).

However, cryptocurrencies' drawbacks are becoming a great concern due to the increased volatility, lack of regulation, and anonymity that define the unpredictability of the cryptocurrency market (Al-Mansour, 2020). The volatility ascending from bitcoins as a result of its price fluctuations, further to investor attention (Al Guindy, 2021), characterizes these very risky investments. Cryptocurrency investment patterns oscillate according to what is being said on different online platforms by celebrities, businessmen and politicians (Jha et al., 2022). This increasing attention in cryptocurrencies' investments, the unknowledge and lack of alertness associated with the interested investors (Hidajat et al., 2021), might lead to a market crash on the economy in the future, as regulatory entities might lose the monetary control they currently exercise on economies (Fujiki, 2021). In addition, according to Fauzi et al. (2020), the consumption of energy and electricity the cryptocurrency mining process takes constitutes a major flaw in sustainability further to the carbon dioxide emissions, strengthening global warming. Regarding the security of the network, whilst some defend its efficiency, others believe blockchain technology is also subject to manipulation and cyber-attacks, as has happened in previous situations, facilitating criminal activity in cryptocurrency systems (Sotiropoulou et al., 2017). The lack of regulation and control from governments and the users' anonymity also encourage illegal activities, such as "the buying and selling of

illegal goods or services online in darknet marketplaces, money laundering, evasion of capital controls, payments in ransomware attacks and thefts" (Houben et al., 2020: p.10).

As suggested by Sotiropoulou et al. (2017), one possible solution for the current lack of regulation in the cryptocurrency market arising from the different classifications and treatments regarding each countries' jurisdiction is by promoting harmonization in the practices and standards on this matter, always following an equilibrium between regulation and innovation. Additionally, in terms of consumer protection, the authors also stated that full disclosure of the risks of investing in cryptocurrencies should be presented to investors, to diminish their lack of knowledge on this subject and, therefore, avoid large and unexpected losses.

In order to have a further understanding of how cryptocurrencies markets develop, it is also relevant to identify its investors' personality and psychological traits to provide them some guidance in optimizing their investments (Kim et al., 2020), as well as their education level on this matter to conclude if they could benefit from investment education programs (Fujiki, 2021). As a result of individuals' behaviors being the reason markets show anomalies and inefficiencies (Al-Mansour, 2020), it becomes fundamental to interpret the major characteristics of investors in the cryptocurrency market, especially, since cryptocurrencies' prices can be influenced by investors' attention (Al Guindy, 2021). As such, studying the different demographic characteristics of cryptocurrency' investors may help to provide a better understanding of this market's dynamics and price movements (Hasso et al., 2019).

According to Yilmaz et al. (2018), the investors of cryptocurrencies can be either categorized into miners or traders. The former are the ones who run the algorithms in their computer devices to create new coins and the latter are investors that keep coins for the purpose of investment or to purchase and sell goods and services. When trying to understand the main factors that identify cryptocurrencies investors' profiles, namely Bitcoin investors, Kim et. al (2020) identified as main variables demographic data, personality and psychological states, online use, and investment patterns measured in a survey. In terms of personality and psychological states, when compared to shares' investors, the authors concluded that Bitcoin investors display higher scores for novelty-seeking – the urge of trying something new –, lower scores in cooperativeness, and, in

terms of fear of missing out, cryptocurrencies investors displayed higher marks, as they have the compulsion to be part of the movement by integrating it (Delfabbro et al., 2021). With respect to online use patterns, bitcoin investors presented a higher number of online connections than stocks' investors (Kim et. al, 2020). For this reason, investors are exposed to an encouragement to continue investing in cryptocurrencies. Hence, the development of protective strategies, as well as community education and regulation are needed to balance and limit these gambling tendencies (Delfabbro et al., 2021). Regarding investment characteristics, the bitcoin group showed significant gambling tendencies, which led the authors to conclude that bitcoin investors tend to behave excessively when trading, showing an irrational optimism when it comes to possible losses (Kim et al., 2020). Cryptocurrencies owners also show high expectations regarding profits and returns, being this the most important factor when considering these investments (Yilmaz et al., 2018). Evidence also shows that investment experience significantly impacts cryptocurrencies' investments (Zhao et al., 2021; Fujiki, 2020).

With regards to socio-demographic characteristics, the cryptocurrency average owner is most likely to be young (Hundtofte et al., 2019; Zhao et al., 2021; Panos et al., 2020), male (Houben et al., 2020; Fujiki, 2021; Hasso et al., 2019; Yilmaz et al., 2018; Yoshino et al., 2020; Fujiki, 2020) and more risk tolerant compared to non-owners (Houben et al., 2020). In other words, the likelihood of holding crypto assets is lower for risk-averse individuals than for non-risk-averse individuals (Yoshino et al., 2020). In this way, risk tolerance is positively associated with cryptocurrency investments (Zhao et al., 2021). Moreover, Hasso et al. (2019) state that males trade more frequently and in a more speculative way than cryptocurrency female traders and end up realizing lower returns. The fact that women tend to choose less risky investment options compared to men could be the result of low levels of financial self-efficacy, i.e., women do not feel as able to make such decisions as men do (Montford et al., 2016). This could be justified not only by the lower confidence women exhibit in their investing abilities compared to men, as well as by their conservative view in this regard (Hira et al., 2008). In addition, women show less excitement and more stress regarding investment decision-making, due to the mental efforts it requires (Hira et al., 2008), which can also be an explanation for the greater number of men actively and riskily investing in the market. Regarding age, one plausible explanation for the younger generation to be more enthusiastic about these

investments could be due to the technologies process that cryptocurrencies involve (Zhao et al., 2021). In terms of education and income, the proportion of people holding crypto assets has exhibited higher education and income levels (Yoshino et al., 2020).

Further to the exponential growth in financial innovation with new risky and complex products and technologies, it is also critical to understand how literate and educated investors are (Yoshino et al., 2020). Thus, the concept of financial literacy behind this type of risky investment is more relevant today than ever. The relationship between these two variables is not consistent amongst empirical research, as depending on the country and dataset under analysis, we will observe distinct results (Fujiki, 2021). On the one hand, it could make sense that the more financially educated and literate investors, assumed to have a well-diversified portfolio with higher returns, would be attracted to these risky investments. On the other hand, a higher level of financial literacy indicates greater awareness of volatile investments and their unpredictability, leading to a less willingness to invest in cryptocurrencies (Panos et al., 2020).

Financial literacy is defined as "the ability to understand how money works in the world and take an informed as well as a judicious decision with regard to all financial activities" (Thavva, 2021: p.1). In other words, financial literacy combines both the skills and knowledge (NFEC) concerning financial topics that allow an individual to confidently act in his best interest, improving his and society's financial wellbeing (OECD, 2014). Knowledge refers to the domain of the concepts and skills to the application of the acquired financial knowledge (Delgadillo, 2014) on financial decisions (Li, 2020). Prior studies show that financial literacy enhances individuals' skills, allowing them to make proper and informed financial decisions, i.e., the level of financial literacy is positively related to financial behavior (Thavva, 2021; Andarsari et al., 2019; Kaiser et al., 2017). According to Atkinson et al. (2012), financial behavior is how a person behaves that impacts his financial wellbeing. Moreover, financial literacy contributes to better financial performance and outcomes (Chu et al., 2017).

Improving financial literacy among individuals constitutes a major interest not only for themselves, but for governments and policymakers, as eliminating financial illiteracy should improve market efficiency (Li, 2020). The enhancement of financial literacy can be observed in distinct domains: retirement planning (Van Rooij et al., 2012), financial

market participation (Chu et al., 2017), investment decisions (Van Rooij et al., 2012; Chu et al., 2017; Allgood et al., 2016), professional advice-seeking (Allgood et al., 2016), credit card behaviors, life insurance (Allgood et al., 2016), portfolio return (Chu et al., 2017), etc. Because of the existing financial literacy gap in relation to age, gender, education, occupation, and income between investors, some specific groups require more attention from financial education programs and policies than others (Yoshino et al., 2020). On average, men, older people, teachers, and self-employed or company employees, with higher education and higher income levels tend to have higher financial literacy levels (Yoshino et al., 2020).

The major issue is how to properly measure financial literacy. Despite showing some limitations, like the low rate of adherence to participate in surveys, as well as the low frequency most surveys are conducted, to measure financial literacy amongst individuals, most studies in the literature adopt the combination of survey-based and self-assessed measurements, as together they capture financial literacy from different dimensions (Li, 2020). According to Li (2020), the survey-based methodology intends to assess individuals' knowledge and perception of financial instruments, individuals' understanding of basic financial principles, and, lastly, individuals' mathematical and numerical skills – all combined, these evaluate objective (or actual) financial literacy (Zhao et al., 2021). Self-assessment of financial literacy corresponds to a subjective field named perceived financial literacy and it attempts to estimate individuals' financial confidence. In this way, objective financial literacy tests what people actually know about financial concepts, whereas perceived literacy reveals what people think they know. Thus, an individual with high perceived financial literacy and low actual financial literacy is considered over-confident (Allgood et al., 2016). Combined, both actual and perceived literacy are equally relevant to explain financial behaviors (Allgood et al., 2016).

In terms of content, four main categories should be part of the actual financial literacy assessment. These include concepts like money basics (time value of money, purchasing power, personal financial accounting purposes), borrowing (use of credit cards, consumer loans, or mortgages), investing (saving accounts, stocks, bonds, or mutual funds) and protecting resources (insurance products and other risk management techniques) (Huston, 2010). Literature usually separates these financial categories into basic and advanced financial literacy (Chu et al., 2017; Van Rooij et al., 2012). The first intends to capture

the understanding of concepts for basic day-to-day financial transactions and planning, while advanced financial literacy regards to more complex questions about financial investments and portfolio choice (Van Rooij et al., 2012).

Zhao et al. (2021) conducted a study to investigate the impact of financial literacy and investment experience on cryptocurrency investment. In general, the authors concluded that cryptocurrency investors had lower levels of objective financial literacy, higher levels of subjective financial literacy, lower levels of perceived risk and higher scores for risk tolerance compared to non-investors. From the analysis, it was concluded that subjective financial literacy and investment experience have a positive impact on cryptocurrency investment, with the latter showing a greater effect. These findings are in line with the fact that subjective knowledge has been proved to lead to more risky investments, as opposed to objective knowledge (Nejad et al., 2018).

It appears that individuals more financially literate are less likely to own cryptocurrencies (Hidajat et al., 2021; Yoshino et al., 2020; Jha et al.) and more likely to not own them in the future, as they are more aware of the arising risks and volatility and tend to be more cautious in their financial decisions (Panos et al., 2020). However, other studies indicate that cryptocurrency' users show a positive level of financial literacy (Williams, 2019; Fujiki, 2020). Likewise, greater levels of financial knowledge have also been associated with cryptocurrencies' owners (Stix, 2021). Overall, Fujiki (2021) concluded that the average cryptocurrencies investor with experience in investing in conventional risky assets tends to be male, young, and more financially literate. Yoshino et al. (2020) found that individuals with higher levels of education are more likely to hold crypto assets, which contrasts with the authors' findings respecting financial literacy, i.e., financial literacy was found to be negatively related to holding crypto assets. Further to this contrary effect, the authors explain that financial education possibly increases individuals' confidence, encouraging them to invest in risky assets, whilst financial literacy leads to more skeptical beliefs around crypto assets. These results offset the expected higher financial education leading to higher financial literacy (Kaiser et al., 2017; Zhang et al., 2019).

As expected, there are inconsistencies in the literature regarding the impact of financial literacy on cryptocurrencies' ownership. Nonetheless, positively or negatively,

financial literacy appears to have a significant impact on cryptocurrency investments. Assuming financial literacy impacts financial behavior, the potential benefits of financial education are substantial, and the costs of financial ignorance are potentially large (Van Rooij et al., 2012). If the majority of investors are financially illiterate and uninstructed, then important concepts are not fully understood to properly deal with the level of risk they are exposed to with these assets (Jha et al., 2022). Aiming to increase financial market efficiency, informed investors should be a priority amongst regulators. Nevertheless, financially literate individuals may still display poor financial decisions and less than optimal behaviors, as a consequence of other factors such as impulsiveness, behavioral biases, unusual preferences and external circumstances (Huston, 2010).

3. RESEARCH QUESTION AND RESEARCH HYPOTHESES

The purpose of this research is to define the profile of cryptocurrencies' investors in Portugal. We aim to identify their personal demographic characteristics and whether financial literacy is a potential investment determinant of crypto-assets. The current state of conclusions regarding the relationship between financial literacy and cryptocurrencies' ownership is not consensus amongst the literature. Thus, this work intends to contribute to this area of study, since, to the best of our knowledge, this is the first related research conducted in Portugal. In this way, the relevance of this investigation is to help regulators identify the common profile of Portuguese cryptocurrencies' investor's, in terms of their personal characteristics and financial literacy level. Consequently, regulatory entities might provide guidance and awareness on this matter towards this group of investors – to be defined as the goal of this study –, enhancing financial consumer protection and, consequently, financial stability (Panos et al., 2020).

Hence, the research question we will address in this paper is "*Do demographic characteristics and financial literacy level of individuals affect their investments in cryptocurrencies in Portugal?*". By answering this matter, we will bring to conclusion if, in Portugal, investors that have their portfolios composed of cryptocurrencies (such as bitcoins, ICOs or others) are financially literate – and really perceive the features of these risky investments – or not. Additionally, we also plan to propose the representative profile of the implicated investors in these arising phenomena that are cryptocurrencies.

In this way, the first hypothesis proposes to assess the impact of demographic aspects, such as gender, age, income level, labor status and education level, on the likelihood of individuals owning crypto assets. In addition, we also aim to identify these investors' relationship towards risk. As previously stated, personal characteristics of individuals influence their investments in financial markets, hence we anticipate finding a positive impact of personal characteristics over these types of investments. According to other findings, we expect the average cryptocurrency investor to have the following profile: male (Houben et al., 2020; Fujiki, 2021; Hasso et al., 2019; Yilmaz et al., 2018; Yoshino et al., 2020; Fujiki, 2020), young (Hundtofte et al., 2019; Zhao et al., 2021; Panos et al., 2020), with higher education level (Yoshino et al., 2020; Saraiva and Gonçalves, 2022), earn a higher monthly income (Yoshino et al., 2020), and be more risk tolerant compared to non-owners (Houben et al., 2020).

Hypothesis 1: *Demographic characteristics of investors associate with cryptocurrencies' investments.*

Concerning the association between financial literacy and cryptocurrency investments, there is no consensus results amongst research, as both negative and positive impacts have been verified on past findings (Hidajat et al., 2021; Yoshino et al., 2020; Jha et al.; Williams, 2019; Fujiki, 2020). Additionally, previous literature (Zhao et al., 2021) has separated financial literacy into objective and subjective, which have led to more solid conclusions in this regard. As such, we chose to proceed accordingly. In relation to subjective financial literacy – a self-assessment measure on individuals' financial knowledge –, as it is linked to riskier investments, it has been positively associated with cryptocurrency investments (Zhao et al., 2021). Thus, the second hypothesis to be confirmed is the following:

Hypothesis 2: *The higher the level of subjective financial literacy of investors, the higher the likelihood of investing in the cryptocurrency market.*

Following the third hypothesis, this relates to the objective field of financial literacy, which measures an individual's factual knowledge on financial matters. Since a higher level of objective financial literacy has been associated both negatively and positively with cryptocurrencies' investments, we formulate the final hypothesis as non-directional. In other words, we will not assume any relationship direction between these two variables.

In case the impact is negative, this can be explained further to a higher awareness of the high volatility – defining these assets – that financially literate investors reveal, recognizing these investments as not beneficial nor worthy of engaging in them. In contrast, a positive effect of objective financial literacy over cryptocurrencies' investments, also observed in previous studies (Williams, 2019; Fujiki, 2020), could be explained due to the greater knowledge, expertise, and skills when it comes to dealing with risky investments. In this way, this hypothesis is created to evaluate the impact of this field of financial literacy over cryptocurrencies' investments.

Hypothesis 3: *Objective financial literacy of investors is associated with the likelihood of investing in the cryptocurrency market.*

4. DATA AND METHODOLOGY

4.1. Data

In order to study the relationship between financial literacy and attitudes to cryptocurrencies in Portugal, the used database was collected from a CMVM conducted survey in the year of 2018. The decision to use this questionnaire is due to its anonymity and large sample size reassured by CMVM. The intention of the survey was to study the level of investors' financial literacy in relation to the securities market in Portugal, as well as investors' attitudes, behaviors, and knowledge towards financial matters. Thus, this CMVM analysis contributed to promoting financial literacy strategies in Portugal, enhancing customer protection, whilst defending the integrity of financial markets (CMVM).

The survey was designed aiming to identify the socio-demographic profile of Portuguese investors, their investment portfolios, the level of their financial knowledge, attitudes towards risk, and behavioral biases (namely, loss-aversion, disposition effect, gambler's fallacy, and ostrich-effect) and lastly, their financial decision-making process in the securities markets (i.e., information sources and factors influencing the process). With a duration of 49 days, the questionnaire was conducted online via CMVM, and other financial intermediaries' websites and the average completion time was 18 minutes. After disregarding 70 invalid answers, the sample has a total number of 2,311 participants, of which 1,192 (52%) are considered investors with at least one financial asset and the remaining 1,119 (48%) are non-investors. According to CMVM definition, investors

correspond to individuals that hold at least one of the following financial assets in their portfolios: shares, bonds, investment funds, government bonds, retirement saving plans, commercial papers, complex financial products, bitcoins, Initial Coin Offerings (ICOs) or other digital currencies, and crowdfunding investments. Further to the results, this sample's investors are mostly male, aged between 25 and 54 years, with larger households and employees with at least a bachelor's degree.

In terms of demographic and socio-economic characteristics, 81.8% of the sample are males, aged between 40 and 69. Regarding education level, 68.8% of the sample have at least a bachelor's degree and 23.3% graduated high school. The majority of the inquired are employees, whilst 22.9% are part of the non-active population, most of them being retired. Regarding the income level of the household, 41.7% indicate a monthly income higher than 2,500€, whereas 16.8% earn less than 1,000€ per month.

Respecting subjective financial literacy – the self-assessment of what individuals believe they know about financial concepts –, 42.1% of the respondents consider themselves moderately knowledgeable and half of the sample recognize their knowledge above the population average. Individuals who do not perceive themselves as informed are mostly non-investors with ages between 40 and 69 years and, on the opposite side, investors aged between 25 and 39 years old classify themselves as knowledgeable or very knowledgeable. In terms of objective financial literacy, the survey evaluates actual skills and expertise on questions including compound interest, the relationship between inflation and the cost of living, the impact of diversification on a portfolio's return, the relationship between interest rates and the price of a bond and, lastly, the concept of guaranteed capital. On average, respondents correctly answered 3.4 questions: 14.6% of the sample chose all right answers, whilst 6.6% chose only wrong answers to all questions. Investors showed a higher number of correct answers compared to non-investors and, consequently, the former group exhibits a higher level of financial literacy. The relationship between financial literacy and demographic characteristics indicates that the group with higher levels corresponds to men, between the ages of 25 and 54. Education appears to be positively correlated with financial literacy, since participants who have concluded a master's degree, MBA or PhD have chosen more correct answers.

Finally, also relevant for our research is the composition of the individuals' portfolios. In a larger percentage of the sample (24.7%), we have investors with at least three types of assets in their portfolios. Regarding cryptocurrencies, the least represented financial asset, we have only 9.9% portfolios with this asset, and they belong to the participants with portfolios consisting of at least five assets. Cryptocurrencies as one-asset portfolios belong only to 6 participants. The main reason investors chose cryptocurrencies is due to a higher expected return. Regarding attitudes towards risk of the participants, 26.2% consider themselves risk averse, 26% risk neutral and approximately 2.2% perceive themselves as very risk tolerant. In addition, investors have higher risk tolerance compared to non-investors.

4.2. Methodology

The goal of this research is to investigate whether financial literacy has any effect on investments in cryptocurrencies. To this end, we intend to construct independent and dependent variables collected from the survey questions and consequently, derive the referred impacts. In this way, the independent variables correspond to the demographic characteristics of investors – including gender, age, education level, labor status and income level –, risk tolerance level, and the subjective and objective spheres of financial literacy. The six characteristic variables will allow us to design the profile of the typical Portuguese cryptocurrencies' investor, whilst the financial literacy ones will lead to the conclusion regarding their knowledge level. Lastly, the dependent variable of this study is cryptocurrencies' ownership.

Starting with the demographic variables, participants' gender (*Gender*) is a dummy variable that only has two possible outcomes: 1 if the participant is female and 0, otherwise.

Regarding the age of the respondents (*Age*), since this was an open-ended question, this variable can assume any whole positive number.

With respect to the participant's education level (*Education*), this is a categorical variable that can adopt six values: 1, if the individual did not conclude basic education level, 2 if the participant has only primary school degree, 3 if the respondent has finished basic school, 4 if the inquired has finished high school, 5 if he/she has or is currently

finishing a college (Bachelor's) degree and 6, for the case the person has a post-graduation, master's degree, MBA or PhD.

Regarding the labor status of individuals (*LaborSafety*), this variable is binary, and it assumes the value of 1 for individuals that are employees or retired (considered secure labor status) and 0 for any other situation – which includes freelancers, unemployed, and students. We create this variable in this way to enable us to compare how the guarantee of having financial stability influences our dependent variable.

The next demographic variable of interest for our study is the monthly income level of participants (*Income*). This variable can range from 1 to 4, being 1, if the income of the individual is below 500€, 2 if it is between 501€ and 1,000€, 3 if it is within 1,001€ and 2,500€, and 4 if the earned income is higher than 2,501€.

Finally, regarding risk perception and tolerance (*RiskTolerance*), this categorical variable assumes scores on a 5-point Likert scale ranging from very risk averse to very risk tolerant. In this way, 5 distinct values can be observed for this subjective variable, where 1 is attributed to very risk averse individuals and 5 to very risk prone ones.

The next step of the variables' construction concerns our main independent variable under study which is financial literacy. Starting with subjective financial literacy (*SubjectiveFL*), this variable aims to evaluate the perception of the participants in terms of their financial knowledge and expertise. The survey incorporates a question stating the self-evaluation of the participant. Following the same method as in previous studies (Zhao et al., 2021; Rooij et al., 2011; Sousa, 2021), the referred question regarding the self-assessment of individuals leads to the creation of the subjective financial literacy variable that can vary from 1 to 5, being 1 the category where individuals who consider themselves with very low knowledge in finance integrate and 5 respects to participants that perceive themselves as very financially knowledgeable.

For the other main area of interest – objective financial literacy –, it is relevant to mention that the survey gathers 5 multiple-choice questions to assess the financial knowledge and skills of participants – the exact wording of the questions measuring objective financial literacy is reported in Appendix 1. We assume financial literacy questions to be coded as follows: blank for unanswered, 0 for wrong answers, and 1 for correct ones.

Firstly, we create the variable *CumFL* which corresponds to the sum of correct answers of the participants. The next step was to standardize this measure to decrease the bias in our estimations. We have the following formula for the creation of variable of objective financial literacy (*ObjectiveFL*):

$$(1) \qquad ObjectiveFL = \frac{CumFL - \min(CumFL)}{\max(CumFL) - \min(CumFL)}$$

In order to provide extra robustness to our models, we opt to introduce two alternative measurements for objective financial literacy. The first one corresponds to a dummy variable – named *AverageScore* – that takes the value of zero if the score of the accumulated answered questions (*CumFL*) is below the sample average, or 1 for the cases that are above the average. The second approach is based on a study performed by Rooij et al. (2011) and relies on a factor analysis, using the Iterated Principal-Factor (IPF) method – leading to the variable *IPF1*. The purpose of the factor analysis is to reduce the number of correlated and similar variables further to their grouping and consecutive creation of new underlying variables. The IPF is an extension of the tool Principal Component Analysis (PCA). This statistical technique intends to reduce the number of variables (dimension) that have similar trends and patterns in the regression model, whilst preserving the maximum possible information (variability) once creating the new reduced variables – the components. In this way, instead of having a high number of correlated variables for each question of objective financial literacy, we summarized these into one component that captures the variation in the data for each question and increases the robustness of our models.

Lastly, for our dependent variable, we intend to measure the likelihood of an individual possessing cryptocurrencies – for instance, bitcoins, ICOs or other digital currencies. In this way, the dependent variable refers to the presence of cryptocurrencies in the participants' portfolios and it is created further to a question in the survey that specifically interrogates participants about the possession of cryptocurrencies in their portfolios. Hence, a binary dependent variable – named *CryptoOwn* – is constructed and can only assume two values: 0 if the survey's participant does not hold any type of cryptocurrency in his portfolio, or 1 otherwise.

5. MODEL

Further to the description of our variables, we must define the model to be employed in the testing of our three research hypotheses and, consequently, answer our research question. We perform the empirical and statistical analysis under the following equation:

$$(2)\ Crypto\ ownership\ =\ \alpha +\ \beta_0\, Gender +\ \beta_1\, Age +\ \beta_2 Education +$$
$$\beta_3\, LaborSafety\ +\ \beta_4\, Income +\ \beta_5\, Risk\ Tolerance +\ \beta_6\, Financial\ Literacy +\ \epsilon$$

For the specified equation, we test it further to a Binary Logistic Regression since our dependent variable is categorical and binary (it assumes only the values of 0 or 1), and intends to model the probability of each event occurring by taking the logarithm of the odds. One of the assumptions of this statistical model is the absence of multicollinearity amongst the independent variables. The explanatory variables should not be linear combinations of each other, otherwise, inflation of the variances of the coefficient estimates will occur (Midi et al., 2010). As such, to test the presence of multicollinearity, we compute the Correlation Matrix, as well as the Variance Inflation Factor (VIF).

We start with the Correlation Matrix, since it is the first step to test the existence of multicollinearity amongst explanatory variables. The rule of thumb indicates that if simple correlation coefficient is greater than 0.8 or 0.9, multicollinearity is a concern for the model estimations. Because we have categorical and numerical variables, the correlation matrix is processed separately – for binary categorical variables, tetrachoric correlation is computed. As it can be observed in Appendix 4, none of our variables appear to be correlated as the criteria previously specified is met – none of the correlations coefficients is superior to 0.8 or 0.9 – and thus, our model does not appear to have multicollinearity.

Due to the correlation matrix not being sufficient on its own to prove the absence of multicollinearity, VIF is a commonly used statistical tool also for this purpose that fits the model into linear regression and then estimates the VIF of each independent variable. If the VIF is higher than 10, our model has a serious multicollinearity concern. As we can see from Table 1, for each independent variable we have a VIF much lower than 10, with the mean being 1.19, indicating that our model has no visible signs of multicollinearity, as the independent variables are not linear combinations of each other.

Table 1 – Variance Inflation Factor

Variable	VIF	1/VIF
SubjectiveFL	1.36	0.737259
ObjectiveFL	1.26	0.793900
Education	1.25	0.801627
RiskTolerance	1.21	0.824156
Age	1.21	0.829665
Income	1.15	0.869299
Gender	1.11	0.899143
LaborSafety	1.01	0.990863
Mean VIF	1.19	

Similar to logit models, we also test our model as Probit. Once again, it is used when the dependent variable is binary, and its coefficients are estimated using the maximum likelihood method. Its purpose is to assess the probability of an observation to be classified as 0 or 1 – in our case, the probability of an individual owning cryptocurrencies. Since the results from the logit and probit models remain similar, we tabulate only the logistic regressions.

6. RESULTS

We first regress our model with the demographic variables and subjective financial literacy (Table 2). From the obtained results, we can clearly state that demographic characteristics like age (at a 1% significance level), gender (at a 10% significance level) and income level (at a 5 % significance level) are statistically significant to explain our dependent variable. As predicted, men are most likely to invest in cryptocurrencies than women. If an individual is male, the log-odds of him owning any type of cryptocurrency increase by 0.57 points compared to female investors. In addition, as expected, age has a negative relationship with the dependent variable, indicating that the log-odds of cryptocurrency ownership by an individual decrease by 0.04 points for each additional unit in his age. In terms of income level, the results suggest that for one unit increase in the monthly disposable income of investors, the log-odds of cryptocurrency ownership increase by 0.27 points. Concerning education and the safety individuals have regarding their labor occupation, these two variables are not statistically

significant to explain cryptocurrency ownership. In terms of risk tolerance of participants – which measures how much risk are investors willing to take and accept regarding financial investments –, as projected, this variable is statistically significant at a 1% significance level to predict the holding of cryptocurrencies in an individual's portfolio. Moreover, the results seem to suggest that risk tolerance is positively associated with our dependent variable, meaning that when the level of risk tolerance of individuals increases one unit, the log-odds of owning cryptocurrencies in their portfolios increase by 0.64 points. Thereby, we validate our first hypothesis under study. Taking into account this evidence, demographic characteristics of individuals, in fact, explain their investments in these types of assets. More specifically, we confirm that gender, age, income level, and risk tolerance levels are associated with cryptocurrencies ownership. The average cryptocurrency owner is expected to be male, younger, earn higher income and be more risk-tolerant compared to non-owners. Regarding education level and the safety each labor status provides to individuals, we exhibit that these do not have a significant role in our sample to influence the dependent variable under study.

Table 2 – Logistic Regression with Subjective Financial Literacy for 2018

Variables	CryptoOwn	CryptoOwn
Gender	-0.5661*	-0.5972*
	(0.3503)	(0.3498)
Age	-0.0392***	-0.0396***
	(0.0082)	(0.0083)
Education	0.0733	0.0639
	(0.1175)	(0.1173)
LaborSafety	0.0977	0.0968
	(0.2206)	(0.2214)
Income	0.2667**	0.2743**
	(0.1286)	(0.1283)
RiskTolerance	0.6370***	-
	(0.1138)	
SubjectiveFL	-0.0392	-0.6747***
	(0.1129)	(0.1879)
*SubFL*Risk*	-	0.1874***
		(0.0335)
Constant α	-3.6335***	-1.4870*
	(0.8832)	(0.8040)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Concerning subjective financial literacy, despite revealing a negative association with cryptocurrency ownership (on the opposite of the literature review), it is not statistically significant to explain it. Therefore, our second hypothesis is initially rejected by verifying that the subjective area of individuals' financial literacy does not have an effect on their likelihood of investing in cryptocurrency.

We decide to introduce an interaction term to test the moderator effect of subjective financial literacy on the dependent variable. Given the importance risk tolerance appears to have in explaining the dependent variable, we decide to introduce an interaction variable (*SubFL*Risk*) between this explanatory variable and subjective financial literacy to assess the effect that the former has on the latter (Table 2). According to the results, subjective financial literacy becomes significant at a 1% significance level and negatively related to cryptocurrency ownership, which means that for an individual with an average level of risk tolerance, it is expected that an increase in his subjective financial literacy level has a negative effect on the log-odds of him investing in cryptocurrencies, more precisely decreasing by 0.67 units. Consequently, we determine that subjective financial literacy has a non-direct and negative marginal effect on cryptocurrency ownership for investors with the same level of risk tolerance. This emphasizes that subjective financial literacy does not have a primary effect on the dependent variable on its own given the other variables, suggesting that we must combine it with the investor's level of risk. When considering the interaction term, also statistically relevant at a 1% level, we conclude that for a unit increase simultaneously in investors' risk tolerance and their self-assessment of financial literacy, the log-odds of owning any type of cryptocurrency increase by 0.19 units. In terms of demographic variables like gender, age, and income level, these remain statistically significant and reveal the same correlation with the dependent variable as in the previous estimation without the interaction term. Regarding education level and labor safety, these demographic variables persist statistically insignificant and have an equal signal relationship as before. We then return to our second hypothesis – the higher the level of subjective financial literacy, the higher the probability of investing in cryptocurrencies –, and conclude that this field of financial literacy is not relevant to explain it on its own, considering the other explanatory variables, such as gender, age, education, labor, income, and risk tolerance. Nevertheless, when adding the interaction between this variable with risk tolerance, our findings show that, in fact, financial literacy

is relevant to explaining cryptocurrency ownership, combined with the level of risk tolerance of participants. Because it is a matter of risk tolerance, when the two variables combined increase, the log-odds of cryptocurrencies ownership increase.

Further to the other main variable of interest, objective financial literacy, we follow our model and obtain the logistic regression in Table 3. Similar to the previous estimation, gender (at a 10% significance level), age (at a 1% significance level) and income level (at a 5% significance level) are the only demographic variables statistically significant in explaining the dependent variable, when considering the objective field of financial literacy. There is statistical evidence suggesting that if an investor is male, young and with a high level of monthly income, his log-odds of owning cryptocurrencies are higher than an investor who is female, older, and earns a lower monthly income. More precisely, for a unit increase in the investor's age, the log-odds of cryptocurrency ownership will decrease by 0.04 units. In the case of income level, one additional level of income increases the log-odds of the investor owning any type of cryptocurrency by 0.27 points. Lastly, if the investor is female, the log-odds of the investor owning these assets in her portfolio should decrease by 0.58 units. As for the variable regarding the risk tolerance of participants, once more, this variable is positively related to our dependent variable and statistically significant at a 1% significance level. If added one level of the risk an investor is willing to take, it is expected that the log-odds of him investing in any cryptocurrencies increase by 0.63 points. Similar to subjective financial literacy, when regressing these variables with objective financial literacy instead, we obtain the anticipated results regarding the profile of these investors, which confirms once again our first hypothesis under review. Demographic characteristics – namely gender, age, and the level of disposable income – and risk tolerance of investors are positively related to investments in cryptocurrencies. The explanatory variable of objective financial literacy appears to be negatively related to investments in cryptocurrencies, however, it is not statistically significant to explain it. In relation to our third hypothesis regarding the possible association of actual financial literacy with these risky investments, we reject it by demonstrating that they are not linked, given the explanatory variables employed in our model.

Table 3 – Logistic Regression with Objective Financial Literacy for 2018

Variables	CryptoOwn	CryptoOwn
Gender	-0.5832*	-0.6421*
	(0.3522)	(0.3514)
Age	-0.0390***	-0.0400***
	(0.0082)	(0.0082)
Education	0.0793	0.0727
	(0.1176)	(0.1169)
LaborSafety	0.0890	0.0974
	(0.2211)	(0.2212)
Income	0.2721**	0.2767**
	(0.1291)	(0.1286)
RiskTolerance	0.6320***	-
	(0.1094)	
ObjectiveFL	-0.2876	-2.9289***
	(0.4836)	(0.7543)
*ObjFL*Risk*	-	0.8074***
		(0.1490)
Constant α	-3.5916***	-1.4822**
	(0.8837)	(0.7814)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In addition, we decide to further explore the unimplied effect of this variable of interest by following the same logic as before: we logistic regress our model with a new interaction term between risk tolerance and objective financial literacy (*ObjFL*Risk*). This interaction variable is created for the purpose of assessing the association between the risk tolerance of individuals and their level of objective (actual) financial literacy when explaining our dependent variable (Table 3). According to the results, the demographic variables like gender, age, and income level remain statistically significant as before at the same significance levels. For the remaining demographic variables, these continue not to be statistically significant, even with the interaction variable added. With reference to objective financial literacy, in this new model, this variable is statistically significant (at a 1% significance level) to explain the dependent variable. In other words, for an individual with an average level of risk tolerance, it is expected that an increase in his financial knowledge decreases the log-odds of him investing in cryptocurrencies by 2.93 points. Additionally, when examining the interaction term itself, statistically significant at a 1% level, we conclude that once increasing both the risk tolerance of the investor as well as his level of financial literacy, it is expected that the log-odds of him owning cryptocurrencies in his portfolio increases by 0.81 units. We argue that objective

financial literacy on its own is not a sufficient driver in our sample to explain our dependent variable due to not having a direct (or first-order) effect on cryptocurrency ownership. Referring to our third hypothesis, objective financial literacy is not associated with cryptocurrency ownership on its own. Yet, combined with the risk tolerance of investors, it is expected that increasing these two variables simultaneously will enhance the likelihood of an individual owning cryptocurrencies.

Furthermore, we test our model with two alternative measurements (detailed in the Methodology chapter) of objective financial literacy for more robustness regarding our hypothesis deductions. The first measure corresponds to a dummy variable – named *AverageScore*. Further to the obtained findings (Table 4), we reckon that objective financial literacy, when measured as a binary variable considering the average financial literacy score of the respondents, appears to be negatively related to the dependent variable, although it is not statistically significant to explain it. Moreover, considering the other explanatory variables, the individual's gender becomes not relevant in explaining the dependent variable. In relation to *Age*, *Income*, and *RiskTolerance*, these independent variables remain statistically relevant for the same significance levels as before. In this way, we conclude that even when regressing our model employing this alternative objective financial literacy measurement, we verify that it continues not to exist an association with cryptocurrency ownership, which is in accordance with our previous conclusions.

The second approach relates to a factor analysis following the IPF method – the variable *IPF1* corresponds to the factor created to summarize the questions of financial literacy by attributing a specific score to each individual. Observing the results of Table 4, we determine that this additional measure of objective financial literacy is still not statistically significant to explain cryptocurrency ownership. Nevertheless, it reveals a distinct feature compared to the other two measures previously employed. When measuring financial literacy further to a factor analysis, the variable presents a positive association, yet insignificant, with cryptocurrency investments. According to our three measurements of financial literacy, on account of none of them appearing to have significance in explaining our dependent variable, we robustly do not find an association between objective financial literacy and cryptocurrency ownership. In other words, in our sample, we cannot state any deductions regarding the direct effect of objective financial

literacy in predicting the log-odds of investing in cryptocurrencies and, therefore, we reject our third hypothesis.

Table 4 – Logistic Regression with Objective Financial Literacy with alternative measurements for 2018

Variables	CryptoOwn	CryptoOwn
Gender	-0.5595	-0.5053
	(0.3510)	(0.3527)
Age	-0.0390***	-0.0382***
	(0.0082)	(0.0083)
Education	0.0655	0.0758
	(0.1171)	(0.1204)
LaborSafety	0.0974	0.1620
	(0.2211)	(0.2270)
Income	0.2612**	0.2337*
	(0.1285)	(0.1298)
RiskTolerance	0.6258***	0.6561***
	(0.1095)	(0.1117)
AboveAverage	-0.0026	-
	(0.2010)	
IPF1	-	0.0231
		(0.0746)
Constant α	-3.6849***	-3.8609***
	(0.8731)	(0.9127)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

6.1. Additional results

We had access to a similar survey conducted in 2020 by CMVM. With the same intention of identifying the main characteristics of this sample's investor profile, this additional questionnaire was released to university students and alumni – contrasting to the 2018 survey that was conducted by CMVM and financial intermediaries. Despite not being reasonable to directly liken the two datasets for the reason that the sample's individuals are fairly distinct, it is intriguing to test our model for 2020 since it was a year characterized by the ascension of the COVID-19 pandemic. Consequently, we intend to question the impact of this health crisis, which turned out to be a worldwide financial recession period, on individuals' attitudes toward cryptocurrencies investments. Thereby, by employing the same statistical variables and model, we test for possible differences.

Starting with the logistic regression of the demographic variables and the perceived level of financial literacy of individuals (*SubjectiveFL*), in Table 5, we can observe some

differences compared to 2018. The demographic characteristics that impact cryptocurrency ownership are slightly distinct. The gender of investors remains statistically significant to explain the dependent variable under study, confirming that females indeed invest less in cryptocurrencies than males, even in times of financial recession like the pandemic of COVID-19. A new demographic variable reveals to be statistically significant at a 5% significance level, that is *LaborSafety*. For an investor that has a stable labor status – i.e., has a secure source of income like employees and retired people – it is expected that the log-odds of him investing in cryptocurrencies decrease by 0.73 points compared to investors with uncertain labor status. Regarding age, education and income levels, these demographic characteristics lose their significance in explaining the dependent variable in 2020. Concerning the level of risk tolerance individuals acknowledge, this variable is statistically significant for 2020 (at a 1% significance level), suggesting that one unit increase in the tolerance of risk of an individual increases the log-odds of him owning cryptocurrencies by 0.51 points. These additional results coincide with our first presented hypothesis regarding the influence of demographic characteristics of investors in terms of cryptocurrency ownership, which remains validated for a distinct sample and financial cycle.

Table 5 – Logistic Regression with Subjective Financial Literacy for 2020

Variables	CryptoOwn
Gender	-1.1172***
	(0.2847)
Age	-0.0036
	(0.0122)
Education	-0.1573
	(0.2309)
LaborSafety	-0.7327**
	(0.3096)
Income	0.2178
	(0.1393)
RiskTolerance	0.5101***
	(0.1197)
SubjectiveFL	0.2181**
	(0.1127)
Constant α	-3.9520***
	(1.1544)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

For the main variable of interest, financial literacy, specifically the subjective field, for the 2020 sample this variable is statistically significant to explain our dependent variable at a 5% significance level. Furthermore, *SubjectiveFL* has a positive association with cryptocurrency investments, which is in accordance with our second hypothesis. One unit increase in the self-assessment of individuals regarding their financial literacy level, leads to an increase of 0.22 units in the log-odds of an individual owning any type of cryptocurrencies. In this way, we return to our second hypothesis and add some interesting deductions. In times of financial crisis, like the COVID-19 pandemic, and for a sample less focused on investors that use traditional financial intermediaries' services, individuals that show a higher level of subjective financial literacy have a higher likelihood of owning cryptocurrencies compared to non-owners. The findings from the 2020 sample suggest that the way individuals recognize their knowledge regarding financial concepts during an economic crisis affects in a positive way their investments in cryptocurrencies.

Regarding the objective field of financial literacy, it is relevant to mention that whilst the 2018 survey gathers 5 questions to assess this variable, the 2020 survey extended this evaluation to 13 questions. Further to the different dimensions, for the 2020 sample, we also apply the relative measurement that creates *ObjectiveFL* aiming to normalize this variable, as mentioned in the Methodology chapter. The results for 2020 employing this independent variable are displayed in Table 6.

Table 6 – Logistic Regression with Objective Financial Literacy for 2020

Variables	CryptoOwn	CryptoOwn
Gender	-1.0575***	-1.0683***
	(0.2941)	(0.2950)
Age	-0.0043	-0.0043
	(0.0123)	(0.0122)
Education	-0.1637	-0.1643
	(0.2292)	(0.2269)
LaborSafety	-0.7583**	-0.7720***
	(0.3106)	(0.3100)
Income	0.2215	0.2222
	(0.1399)	(0.1398)
RiskTolerance	0.5552***	-
	(0.1172)	
ObjectiveFL	1.1221	-1.1467
	(0.8214)	(0.9987)
*ObjFL*Risk*	-	0.7354***
		(0.1564)
Constant α	-4.1742***	-2.4660**
	(1.2022)	(1.1385)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Further to the new outcomes, *Gender* remains statistically significant at a 1% significance level, as well as *LaborSafety* at a 5% significance level. If the participant of the 2020 survey is female, the log-odds of her owning cryptocurrencies in her portfolio decrease by 1.06 points compared to males. Overall, we conclude that regardless of the year and sample under analysis, females are less likely to be investing in cryptocurrencies than men. The safety provided by the labor status of an individual negatively impacts cryptocurrency ownership i.e., an individual that is either employed or retired – and, in this way, has a secure source of income – has lower log-odds of investing in cryptocurrencies, by precisely 0.76 points compared to the other labor status. For the remaining demographic variables, including age, education and income levels of individuals, these are not statistically significant in our model of 2020 in explaining the dependent variable. Regarding the risk tolerance of individuals, this variable persists to be statistically significant (at a 1% significance level) with a positive correlation with cryptocurrency ownership, indicating that the higher the tolerance an individual has towards risk, the higher the log-odds of that individual owning any type of cryptocurrency in his portfolio. Despite of the year and sample under analysis, risk tolerance of

individuals affects cryptocurrency ownership. These results suggest, once more, the influence of individuals' demographic characteristics on cryptocurrency investments, validating our first hypothesis.

Finally, in relation to objective financial literacy, even though it correlates positively with cryptocurrency ownership (on the opposite of the year 2018), we conclude that it is not statistically significant in explaining the dependent variable, given the other independent variables, even in economic recession periods and distinct sample selection process. Once again, we state that an individual's actual knowledge and skills about finance do not affect nor impact the likelihood of him investing in any crypto-asset and, therefore, we confirm that it is not a matter of objective financial literacy, which is consistent with our evidence for 2018 – rejecting our third hypothesis.

Further to objective financial literacy not being significant on its own, and as we have previously tested for the 2018 sample, we generate an interaction term (*ObjFL*Risk*) between objective financial literacy and risk tolerance to delve deeper into the possible effect an increase in these two variables generates on the likelihood of cryptocurrency ownership (Table 6). As expected, we have the same demographic variables explaining the dependent variable. Nevertheless, in this sample, we observe distinct results for the model employing the interaction variable. Objective financial literacy, even when including an interaction variable with risk tolerance, remains statistically insignificant, which reinforces our earlier findings regarding the non-association between the level of financial literacy of individuals on its own and their investments in cryptocurrencies. Consequently, objective financial literacy by itself is not statistically relevant to explain investments in cryptocurrencies, despite the sample, as well as the economic period under study. Additionally, the newly formed variable is in accordance with the data from 2018, implying that a simultaneous increase in both the levels of financial literacy and risk tolerance of individuals, leads to an increase of the log-odds of cryptocurrency ownership, by precisely 0.74 points in this case.

Furthermore, the differences in our results across the two samples may point to potential explanations for the mixed results in extant literature. Depending on the underlying characteristics of the sampling process, socio-demographic and financial literacy associate differently with crypto-assets ownership likelihood. For the 2020

sample of our research – which was composed further to universities' students and alumni –, perceived financial literacy positively impacts participants' investments in these assets. Regarding 2018, whose survey was made available via CMVM, and other financial intermediaries' websites, the level of knowledge an individual considered himself to have does not influence his investments in cryptocurrencies. A plausible explanation for this difference could be due to the possibility that participants of the 2018 sample were taking advantage of financial intermediaries' services – as the responses were collected by CMVM and other financial institutions' websites. In this way, the 2020 sample individuals (generated further to universities' announcements) perhaps were not benefiting from the referred services and, therefore, perceived themselves as knowledgeable enough to invest in cryptocurrencies – a condition not relevant to the 2018 group. Another justification for the subjective financial literacy to be relevant only in 2020 could be due to the recession and challenging times individuals were facing further to the pandemic. To be investing in such volatile assets as cryptocurrencies required a considerably higher level of confidence in terms of financial expertise from individuals. Thus, investors who did not consider themselves that knowledgeable were not significantly involved in owning cryptocurrencies in their portfolios during such uncertain times.

7. CONCLUSIONS

The purpose of our study is to consider the effect of the financial literacy of individuals on investments in cryptocurrencies and determine the possibility of an association. In addition, the main characteristics of these investors are also investigated.

To proceed accordingly, we work through a questionnaire provided by CMVM and conducted in 2018 by financial intermediaries, designed to understand the profile and characteristics of Portuguese investors. Based on the quantitative analysis performed, we infer that investors who are male, young, more risk-tolerant, and earn a higher income have a greater likelihood of investing in these assets. Both fields of financial literacy tested in our assessment – i.e., subjective and objective – are not relevant to affect cryptocurrency ownership in this sample. Concerning the objective sphere, not even when employing alternative measurement methods, this variable appears to be significant. We perform an in-depth analysis regarding the two fields of financial literacy by combining

them individually with the risk tolerance of individuals, given the large significance the latter appears to have on cryptocurrency ownership. This procedure enables us to draw conclusions about the indirect effect that financial literacy has on this sample: an increase in financial literacy and risk tolerance simultaneously improves the likelihood of an investor holding the concerned assets.

We present additional analysis for a similar survey conducted in 2020 (the year of the COVID-19 pandemic rise) to university students and alumni. Even though the two samples are not directly comparable due to the diverse participants, we reach interesting insights. For 2020, owners are more likely to be male, have higher tolerance towards risk, and have an uncertain labor status compared to non-owners. Concerning financial literacy, only the subjective field – that attempts to classify individuals' self-assessment of financial literacy – is associated with cryptocurrency ownership. The findings indicate that the higher the level of an investor's subjective financial literacy, the higher the likelihood of that investor being part of the cryptocurrency market. For the other main area of financial literacy, no evidence is found that shows any direct association. Nevertheless, further to the creation of an interaction variable, we confirm that an increase in the level of risk tolerance of individuals, as well as their level of factual financial literacy, enhances the likelihood of owning any type of cryptocurrency in individuals' portfolios.

Distinct datasets rise quite distinct results. Overall, we demonstrate that the demographic characteristics of investors have a considerable role in explaining cryptocurrency investments. Despite being from separate samples, we provide evidence that an individual's gender, age, disposable monthly income level, and the safety level of labor status all contribute to cryptocurrency ownership. Specifically, in times of financial crisis and in a sample formed by university students and alumni, only gender and the safety of the labor status of investors – i.e., if individuals have a stable source of income – are relevant to explain cryptocurrency investments. Regarding the risk tolerance of individuals, the results suggest that it has a high positive influence on cryptocurrency ownership, regardless of the year and sample in question, i.e., the greater an individual's tolerance towards risk, the higher the likelihood of him owning cryptocurrencies. Considering our main explanatory variable of interest, financial literacy, in the specific case of the objective sphere, there is no statistical indication that it affects (positively or

negatively) cryptocurrency ownership for either tested sample. In other words, cryptocurrency investments do not depend on how financially educated and knowledgeable investors are. In terms of the additional field, subjective financial literacy has a positive effect on the ownership of these risky investments only for the 2020 sample. During the pandemic, investors who perceived to have a higher level of confidence regarding their financial expertise, had a higher likelihood of investing in any cryptocurrency. The pandemic triggered major consequences on the worldwide economy and financially impacted households in a way that was not anticipated. To be investing in risky assets like cryptocurrencies during this period required a specific level of confidence (subjective financial literacy) from individuals, unlike in 2018, a year of financial stability.

The main limitation of this study relates to the lack of information regarding investors' real intentions towards cryptocurrencies. Further to our findings, we consider it is pertinent to extend this analysis to the reasonings and behaviors that lead cryptocurrency investors to be part of this phenomenon, apart from their personal characteristics and financial literacy level. In this way, our research raises the following questions to be explored in the future: What is the primary reason these investors continue to invest in crypto? Are they just afraid of missing out? Do they actually believe that cryptocurrency returns outweigh the existing risks?

Our investigation is pertinent for regulatory entities. Due to most cryptocurrency' investors being young with a high level of tolerance towards risk, it should be analyzed the possibility of introducing guidelines and advice by the responsible central authorities regarding these assets. Since no association between actual financial literacy and these investments was observed, we have no way of stating that the concerned investors completely recognize the risks that arise from these assets. For instance, full risk disclosure by the related authorities could aid the concerned investors, as well as future interested ones, providing them with reliable and independent information on this matter to improve their awareness. According to our findings, Portuguese regulators could concentrate their assistance actions regarding cryptocurrencies on the specific investor profile outlined in this research.

REFERENCES

Abdi, H., & Williams, L. J. (2010). Principal component analysis. Wiley interdisciplinary reviews: computational statistics, 2(4), 433-459.

Al Guindy, M. (2021). Cryptocurrency price volatility and investor attention. International Review of Economics & Finance, 76, 556-570.

Allgood, S., & Walstad, W. B. (2016). The effects of perceived and actual financial literacy on financial behaviors. Economic inquiry, 54(1), 675-697.

Al-Mansour, B. Y. (2020). Cryptocurrency market: Behavioral finance perspective. The *Journal of Asian Finance, Economics, and Business*, 7(12), 159-168.

Almeida, J., & Gonçalves, T. C. (2022). A Systematic Literature Review of Volatility and Risk Management on Cryptocurrency Investment: A Methodological Point of View. *Risks*, 10(5), 107.

Andarsari, P. R., & Ningtyas, M. N. (2019). The role of financial literacy on financial behavior. *Journal of accounting and business education*, 4(1), 24-33.

Ankenbrand, T., & Bieri, D. (2018). Assessment of cryptocurrencies as an asset class by their characteristics. Investment management and financial innovations, (15, Iss. 3), 169-181.

Atkinson, A. and F. Messy (2012), "Measuring Financial Literacy: Results of the OECD / International Network on Financial Education (INFE) Pilot Study", OECD Working Papers on Finance, Insurance and Private Pensions, No. 15, OECD Publishing, Paris

Baek, C., & Elbeck, M. (2015). Bitcoins as an investment or speculative vehicle? A first look. Applied Economics Letters, 22(1), 30-34.

Bannier, C., Meyll, T., Röder, F., & Walter, A. (2019). The gender gap in 'Bitcoin literacy'. *Journal of Behavioral and Experimental Finance*, 22, 129-134.

Chu, Z., Wang, Z., Xiao, J. J., & Zhang, W. (2017). Financial literacy, portfolio choice and financial well-being. Social Indicators Research, 132(2), 799-820.

CMVM – Questions and Answers for Investors on Crypto-assets

Colombo, J., Cruz, F., Paese, L., & Cortes, R. (2021). The diversification benefits of cryptocurrencies in multi-asset portfolios: cross-country evidence. Available at SSRN 3776260.

Delfabbro, P., King, D. L., & Williams, J. (2021). The psychology of cryptocurrency trading: Risk and protective factors. *Journal of behavioral addictions*, 10(2), 201-207.

Delgadillo, L. M. (2014). Financial clarity: Education, literacy, capability, counseling, planning, and coaching. *Family and Consumer Sciences Research Journal*, 43(1), 18-28.

European Central Bank. (2012). Virtual currency schemes. Virtual currency schemes, 1-55.

Fauzi, M. A., Paiman, N., & Othman, Z. (2020). Bitcoin and cryptocurrency: Challenges, opportunities and future works. *The Journal of Asian Finance, Economics, and Business*, 7(8), 695-704.

Fujiki, H. (2020). Who adopts crypto assets in Japan? Evidence from the 2019 financial literacy survey. *Journal of the Japanese and International Economies*, 58, 101107.

Fujiki, H. (2021). Crypto asset ownership, financial literacy, and investment experience. Applied Economics, 53(39), 4560-4581.

Gonçalves, T. C. (2022). The Impact of Discretionary Measurement Criteria on Investors' Judgement and Decisions. *Games*, 13(1), 3.

Hackethal, A., Hanspal, T., Lammer, D., & Rink, K. (2019). The Characteristics and Portfolio Behavior of Bitcoin Investors: Evidence from Indirect Cryptocurrency Investments. Forthcoming, Review of Finance, SAFE Working Paper, (277).

Hasso, T., Pelster, M., & Breitmayer, B. (2019). Who trades cryptocurrencies, how do they trade it, and how do they perform? Evidence from brokerage accounts. *Journal of Behavioral and Experimental Finance*, 23, 64-74.

Hidajat, T., Kristanto, R. S., & Octrina, F. (2021). Measuring Bitcoin Literacy in Indonesia. *The Journal of Asian Finance, Economics and Business*, 8(3), 433-439.

Hira, T. K., & Loibl, C. (2008). Gender differences in investment behavior. In Handbook of consumer finance research (pp. 253-270). Springer, New York, NY.

Houben, R., & Snyers, A. (2020). Crypto-assets: Key developments, regulatory concerns and responses.

Hundtofte, S., Lee, M., Martin, A., & Orchinik, R. (2019). Deciphering Americans' views on cryptocurrencies. Liberty Street Economics https://libertystreeteconomics. newyorkfed. org/2019/03/deciphering-americans-views-on-cryptocurrencies. html.

Huston, S. J. (2010). Measuring financial literacy. *Journal of consumer affairs*, 44(2), 296-316.

Jha, R., & Awasthi, S. Topic: Financial literacy of novice cryptocurrency investors.

Kaiser, T., & Menkhoff, L. (2017). Does financial education impact financial literacy and financial behavior, and if so, when?. The World Bank Economic Review, 31(3), 611-630.

Kim, H. J., Hong, J. S., Hwang, H. C., Kim, S. M., & Han, D. H. (2020). Comparison of psychological status and investment style between bitcoin investors and share investors. Frontiers in Psychology, 3230.

Li, X. (2020). When financial literacy meets textual analysis: A conceptual review. *Journal of Behavioral and Experimental Finance*, 28, 100402.

Midi, H., Sarkar, S. K., & Rana, S. (2010). Collinearity diagnostics of binary logistic regression model. *Journal of Interdisciplinary Mathematics*, 13(3), 253-267.

Montford, W., & Goldsmith, R. E. (2016). How gender and financial self-efficacy influence investment risk taking. *International Journal of Consumer Studies*, 40(1), 101-106.

Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. Decentralized Business Review, 21260.

Nejad, M. G., & Javid, K. (2018). Subjective and objective financial literacy, opinion leadership, and the use of retail banking services. *International Journal of Bank Marketing*.

Panos, G. A., Karkkainen, T., & Atkinson, A. (2020). Financial literacy and attitudes to cryptocurrencies.

Saraiva, T., & Gonçalves, T. C. (2022). Should I Play or Should I Go? Individuals' Characteristics and Preference for Uncertainty. *Games*, 13(2), 31.

Sotiropoulou, A., & Guégan, D. (2017). Bitcoin and the challenges for financial regulation. *Capital Markets Law Journal*, 12(4), 466-479.

Sousa, D. (2021). The Association Between Financial Literacy and Financial Market Participation.

Stix, H. (2021). Ownership and purchase intention of crypto-assets: survey results. Empirica, 48(1), 65-99.

Thavva, Sudeshna. (2021). A Study on Financial Literacy and Financial Behaviour. Conference: Changing Paradigms in Management Practices. Available at: https://www.researchgate.net/publication/349238535_A_Study_on_Financial_Literacy_and_Financial_Behaviour [Accessed on 27/02/2022]

Van Rooij, M. C., Lusardi, A., & Alessie, R. J. (2012). Financial literacy, retirement planning and household wealth. *The Economic Journal*, 122(560), 449-478.

Van Rooij, M., Lusardi, A., & Alessie, R. (2011). Financial literacy and stock market participation. *Journal of Financial economics*, 101(2), 449-472.

Williams, A. S. (2019). An investigation into the Personal Financial Literacy of Cryptocurrency users (Doctoral dissertation, Rhodes University).

Yermack, D. (2015). Is Bitcoin a real currency? An economic appraisal. In Handbook of digital currency (pp. 31-43). Academic Press.

Yilmaz, N. K., & Hazar, H. B. (2018). Predicting future cryptocurrency investment trends by conjoint analysis. *Journal of Economics Finance and Accounting*, 5(4), 321-330.

Yoshino, N., Morgan, P. J., & Long, T. Q. (2020). Financial literacy and fintech adoption in Japan.

ZHang, H., & Xiong, X. (2019). Is financial education an effective means to improve financial literacy? Evidence from rural China. Agricultural Finance Review.

Zhao, H., & Zhang, L. (2021). Financial literacy or investment experience: which is more influential in cryptocurrency investment?. *International Journal of Bank Marketing*.

APPENDICES

Appendix 1 – Variables Construction

Variable's name	Survey's question
Age	Please indicate your age: _____ years old
Gender	Please indicate your gender 1. Female 2. Male
Education	What is your maximum level of education? 1. No basic education 2. Full primary education (4th year/4th class) 3. Complete basic school (9th grade) 4. High school level (12th grade) 5. College (Bachelor's) degree 6. Master's/MBA/PhD
LaborSafety	What is your current labor status? 0. Other 1. Freelancer 2. Employer 3. Unemployed 4. Retired 5. Student
Income	What is the MONTHLY INCOME AVAILABLE (i.e., after taxes) of your household? That is, how much money (approximately) does your household have, per month, available BEFORE any expense? 1. Up to 500€ 2. Between 501€ and 1000€ 3. Between 1001€ and 2500€ 4. Above 2500€
RiskTolerance	How would you rate your risk level when investing in securities? 1. Very risk-averse / I really don't like to take risks 2. Risk-averse / I don't like to take risks 3. Risk neutral / I'm indifferent towards risking 4. Risk-lover / I like taking risks 5. Very risk-lover / I really like taking risks
SubjectiveFL	How would you rate your knowledge regarding financial products and markets? 1. Not knowledgeable at all 2. A bit knowledgeable 3. Moderately knowledgeable 4. Knowledgeable 5. Very knowledgeable

ObjectiveFL	Suppose you have €100 in a bank account whose interest rate is 1% per year. After 5 years, how much will the account balance be if no money is withdrawn, nor are there commissions or associated taxes (i.e., at the end of each year let the interest amount stay in that same bank account)? 1. Over €105 2. Exactly €105 3. Less than €105 Suppose you have €100 in a bank account whose interest rate is 1% per year and that inflation is 2% per year. A year from now, what do you think you could buy with the money in that account? 1. I'd buy more stuff than I do today. 2. I'd buy exactly the same things as today. 3. I'd buy less stuff than I do today. 4. It depends on what I would buy. You have invested in a bond that pays a fixed interest rate. Meanwhile, market interest rates have decreased. If you sell that bond after this decrease, the price of this bond shall be: 1. Lower than the price at which you bought it 2. Equal to the price at which you bought it 3. Higher than the price at which you bought it In your opinion, please indicate whether the following statement is true or false: "Investing in a company's stock typically provides a safer return than investing in a stock fund." 1. True 2. False What does it mean security to have guaranteed capital on the maturity date? 1. I am entitled to receive the money invested at any time 2. On the maturity date I always receive the money invested 3. The issuer of the securities reimburses the money invested on the maturity date, provided that it has financial conditions to do so
CryptoOwn	Indicate which of the following financial products you currently own... "Investments in Bitcoins, ICOs, and other digital currencies" 1 - Do not own 2 - Own

Appendix 2 – Descriptive Statistics for 2018

Variable	Obs	Mean	Std. Dev.	Min	Max
Gender	1,337	0.1503366	0.3575348	0	1
Age	1,337	45.73747	13.67482	3	89
Education	1,337	4.904263	0.8787859	1	6
LaborSafety	1,337	0.7726253	0.4192934	0	1
Income	1,332	3.183934	0.8421361	1	4
RiskTolerance	1,332	2.984985	1.052955	1	5
SubjectiveFL	1,337	3.323111	0.9526263	1	5
*SubFL*Risk*	1,332	10.27928	5.165052	1	25
ObjectiveFL	1,337	0.7153328	0.2146151	0	1
*ObjFL*Risk*	1,332	2.186937	1.062485	0	5
AboveAverage	1,337	0.5811518	0.493555	0	1
IPF	1,315	-5.32e-08	1.482337	-6.121694	1.537646
CryptoOwn	1,332	0.1066066	0.3087284	0	1

Appendix 3 – Descriptive Statistics for 2020

Variable	Obs	Mean	Std. Dev.	Min	Max
Gender	1,786	0.480963	0.4997774	0	1
Age	1,786	31.88018	13.69926	17	99
Education	1,786	5.293953	0.6028293	1	6
LaborSafety	1,786	0.4255319	0.4945619	0	1
Income	1,786	2.180851	1.023145	1	4
RiskTolerance	1,786	2.452408	1.007105	1	5
SubjectiveFL	1,786	2.932811	1.109656	1	5
ObjectiveFL	1,786	0.7076837	0.1610225	0	1
*ObjFL*Risk*	1,786	1.752175	0.8628376	0	5
AboveAverage	1,786	0.4675252	0.499084	0	1
IPF	1,665	1.38e-08	1.292431	-4.950268	1.958352
CryptoOwn	1,786	0.0503919	0.2188136	0	1

Appendix 4 – Correlation Matrix

	Age	*Education*	*Income*	*RiskTolerance*	*SubjectiveFL*	*ObjectiveFL*	*Gender*	*LaborSafety*	*CryptoOwn*
Age	1.0000								
Education	-0.2994	1.0000							
Income	0.1534	0.1862	1.0000						
RiskTolerance	-0.1240	0.0398	0.0794	1.0000					
SubjectiveFL	-0.1880	0.2467	0.1969	0.3491	1.0000				
ObjectiveFL	-0.0917	0.2520	0.2015	0.2214	0.3720	1.0000			
Gender	N/A	N/A	N/A	N/A	N/A	N/A	1.0000		
LaborSafety	N/A	N/A	N/A	N/A	N/A	N/A	0.0029	1.0000	
CryptoOwn	N/A	N/A	N/A	N/A	N/A	N/A	-0.2321	0.0041	1.0000