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Financial Literacy and Attitudes to Cryptocurrencies

By *Georgios A. Panos and Tatja Karkkainen*

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1. Introduction

The emergence of cryptocurrencies was a major turning point for the financial world and signaled the initiation of the FinTech era. Around 2009, the Bitcoin appeared as a digital or cryptocurrency, relying on both cryptography and the blockchain technology. Together with other technologies, they enable anonymous transactions to occur at a peer-to-peer level, without third-party verification. As of today, there are some 2,000 cryptocurrencies in circulation, with a market capitalization between $200 and 300 billion. Their adoption and popularity have increased rapidly after 2017. The supply of cryptocurrencies is typically limited and inherently complex. In the case of the bitcoin, it involves 'mining', i.e. generation via the solution of cryptographic puzzles of increasing difficulty and third-party verification of the solution. While the circulating and maximum supply of cryptocurrencies, such as the bitcoin, has been the subject of academic discussion, much less is known about the demand side in the market for cryptocurrencies. The demand for cryptocurrencies, such as the bitcoin, is largely unpredictable (Baur, et al., 2015). In a recent seminal study, Foley, et al. (2019) estimate that around $76 billion of illegal activity per year involve the bitcoin. This amounts to some 46% of the total bitcoin transaction. Evidently, individuals who engage in such transactions are quasi-sophisticated in their line of work and must be relatively well-equipped for the purposes for which the engage with cryptocurrency transactions. Moreover, such individuals are less likely to reveal their motivation, preferences and the specifics of their engagement with cryptocurrencies. In addition, Rooney and Levy (2018) point out to the emergence of some 300 'cryptofunds' that have been initiated, i.e. as hedge funds with sole engagement in cryptocurrencies. These are actively managing some $10 billion in assets.

This study sheds further light on the demand for cryptocurrencies such as the bitcoin, via examining the determinants of attitudes to cryptocurrencies in a global survey from 15 counties. We attempt to identify the characteristics of cryptocurrency users and prospective users, emphasizing on their understanding of the fundamental financial concepts, in terms of their financial literacy. Cryptocurrency users who are engaged in illegal activity are less likely to respond to surveys. So are the managers of 'cryptofunds'. Since cryptocurrencies are relatively new financial instruments that are readily available to households, we aim to examine the characteristics of the remaining or ordinary users. We aim to assess whether

such users have adequate financial knowledge and skills to engage in inherently complex, risky, and volatile financial instruments. Are cryptocurrency users well-equipped to make financial decisions? Do they possess adequate financial literacy and knowledge? Are the able to anticipate and understand the high financial risk involved in a very volatile new instrument? Are technological literacy skills, youth, preference for informal practices, and financial advice adequate to complement for the absence of any relevant financial literacy skills? Evidently, the investigation of the relationship between financial literacy and attitudes to cryptocurrencies is important for a number of reasons.

Firstly, financial markets and instruments are already considered complex by the majority of non-expert users (e.g. Remund, 2010; Van Rooij, *et al.*, 2011) and the FinTech era is likely to introduce novel types of instruments and intermediation activities. These are likely to be available for adoption to wider audiences and all households, via the facilitation by technology, and without necessarily entailing intermediation, advisory and/or monitoring by an authorized body. In the novel territories of the FinTech era, the ability by individuals to engage in informed financial decision making becomes paramount. Secondly, cryptocurrencies have been characterized by extremely high volatility. One of the key tenets of the global financial literacy enhancement agenda has emphasized on the ability to understand and assess the financial risk involved in different options. Intuitively, one would expect the more financially literate to be less likely to engage in a highly volatile new instrument and in transactions driven by unrealistically high promised rewards or by sentiment and imitation.

Thirdly, cryptocurrencies have spurred a great amount of debate in the financial-services industry, the academic community, and among policymakers and regulators. Moreover, they have acquired ‘sworn’ enemies and ‘zealot’ followers. They have received thrilling appraisals by certain new technology and investment gurus. They have attracted a large volume of new investors and speculators, and they are very frequently the subject of discussion in the media. New ideas entailing notions of ‘stablecoins’, which possess features of both crypto and fiat money, have been put forward as the future of the market for cryptocurrencies. The proposal is for these to be pegged or linked to a major currency such as the dollar of the euro. One such instance is the inception of Libra by Facebook, which was aspired to go in circulation in 2020, but has also recently seen criticism by

investors and regulators, including the US Congress, the Federal Reserve Board, and the Financial Stability Board. In particular, Randal K. Quarles, the chairman of the Financial Stability Board, warned the finance ministers and central-bank governors of the G20 in writing that stablecoins are likely to become a source of threat to global financial markets (FSB, 2019). Regulators are concerned because of the limited insight and monitoring capacity in cryptocurrencies and the several likely, but poorly anticipated, risks entailed in such new instruments (Foley, et al., 2019). In an early study, Glaser, et al. (2014) reports '*strong indications that especially uninformed users approaching digital currencies are not primarily interested in an alternative transaction system but seek to participate in an alternative investment vehicle*'[1].

If the cryptocurrency market is dominated by illegitimate users, few sophisticated 'cryptofund' managers, many speculators, and many more unsophisticated and less financially literate investors, then these concerns and sources of threat are entirely justified. For any financial market and instrument to function efficiently, there needs to be a balanced combination of legitimate informed investors and speculators. If a market is dominated by users interested in illegal affairs and by unsophisticated investors, then the future of that market is likely to be opaque and can be threatening if it becomes mainstream and attracts even more less sophisticated users.

Our main empirical question is whether the more financially literate are more likely to engage in the market for cryptocurrencies, in terms of owning and/or intending to own cryptocurrencies. We are also interested in the mechanisms underlying any such relationship, i.e. if any effect of financial literacy is mediated by technological literacy, youth, inclination to informal practices, financial advice, or the enhanced understanding of the financial risk involved in cryptocurrencies. With all the media attention and the likely peer pressure by other acclaimed cryptocurrency users, it is likely that more risk tolerant individuals or individuals with limited risk awareness or erroneous risk perceptions are prone to indulge in sentiment-driven decision making and peer pressure. It is of interest to

[1] The authors use trading data from a Bitcoin exchange, transaction data from the Bitcoin Blockchain, visitor statistics for the Bitcoin Wikipedia article and dates of important Bitcoin events.

examine if the more financially literate, particularly the more risk tolerant types, are better enabled to resist the temptation of undertaking risky investment in cryptocurrencies.

Our study utilizes data from the ING 2018 Global International Survey on Mobile Banking. The survey questioned individuals in 15 countries online and over the phone. Counties include the USA, Australia, the United Kingdom, several members of the European Union, along with countries in Easter Europe and Central Asia (hereafter ECA). Apart from the usual demographics, and the usage of mobile banking, the survey inquired regarding attitudes to cryptocurrencies, in terms of having heard of cryptocurrencies, currently owning, intending to own in the future, and/or not intending to own (ING, 2018). Our empirical approach matches the data from this survey with data from the S&P 2014 Global Financial Literacy Survey (Klapper, Lusardi and von Oudheusden, 2015). This exercise enables the generation of a financial literacy proxy, based on the gender, age and income profile of individuals by county. We generate our financial literacy proxy, based on the probability to have responded correctly to questions for at least 3 out of the 4 main financial literacy concepts, namely inflation, simple interest/numeracy, compound interest, and financial risk. Our measure approximates this probability based on a score calculated as the average percentage of 3-out-of-4 correct concepts for respondents of a given gender, age group (15-34, 35-54, ≥55) and income group (top 60%, bottom 40%) in each country. We also experiment with additional financial-literacy proxies that absolve any country-level differences in financial literacy.

The ING International Survey shows that 8.7% of the respondents in the 15 countries own some cryptocurrency. Moreover, 13.3% do not own but intend to own in the future. Some 43% of the sample do not own and do not intend to own cryptocurrencies. There is also a remaining 34.5%, who have never heard of cryptocurrencies before. The figures might seem high, but they are similar to those found in a survey by Yougov in the USA, showing that some 9% of respondents that had heard about cryptocurrencies had bought Bitcoin whilst 5% had mined them (Yougov, 2018b; 2019). Jakubauskas (2018) reports rates of ownership of 9% in Great Britain and 6% in Germany. Our weighted figures for cryptocurrency ownership are 8.2% in the USA, 6.6% in Australia, 6.5% in the United Kingdom, and 8.1% in Germany. The figures are also in line with cryptocurrency benchmarking study by Rauchs, et al. (2018) and the reports by Yougov, (2018a) and the

FCA (2019). The figures for ownership and intension to own are notably high among the Europe and Central Asia (hereafter *ECA*) countries in the sample, i.e. Turkey, Romania, the Czech Republic, and Poland. A striking 17.4% if the sample in Turkey own some cryptocurrency, with an additional 24.2% not owning but intending to own in the future. Spain also exhibits high figures of current and prospective ownership, i.e. 10.3% and 18.1%, respectively. The survey also shows that males, the younger, and the more educated are more likely to engage in the cryptocurrency market.

We estimate weighted multinomial probit models of attitudes to cryptocurrencies, in terms of four categories capturing current ownership, the intension to own in the future, no intension to own in the future, and having heard of cryptocurrencies. Our financial literacy proxy is the independent variable of main interest, but we also include a rich set of control variables for demographic characteristics, and PPP-deflated monthly income per capita. We also generate proxies for technological literacy, preference for cash as an indication of inclination to informal practices, and generic risk tolerance captured by the future-tense orientation of the respondent's language (Chen, 2013).

To our knowledge, this is the first study to examine the relationship between financial literacy and attitudes to cryptocurrencies. Our estimates reveal that the more financially literate are less likely to own cryptocurrencies. They are more likely not to intend to own them in the future. Expectedly, they are more likely to have heard of cryptocurrencies before. The results are economically and statistically significant. A 0.1 increase in our financial literacy proxy decreases the probability of ownership by 24.1% or by 2.08 percentage points − from 8.63% to 6.55%. An interquartile increase in financial literacy decreases the probability of ownership by some 38.1%. A 0.1 increase in financial literacy increases the intension not to own cryptocurrencies in the future by 15.9% and an interquartile change in financial literacy increased it by 32.7%. The respective effects for the probability to have heard of cryptocurrencies are -13.9% and -22.7% respectively. The results are robust in models with interaction terms between financial literacy and country[2], as well as financial literacy, education, and income. The results are also robust in models

[2] These models also indicate some country heterogeneity in cryptocurrency ownership, in terms of positive effects of the interaction terms between financial literacy and Germany, Luxembourg, the Netherlands, Australia, and the Czech Republic.

using bootstrapping, unweighted models, and models using alternative financial literacy proxies which absolve any country-level differences in financial literacy. Finally, they are robust to the usage of a multinomial probit model with selection, in which awareness of cryptocurrencies is the dependent variable in the first stage. The model is identified via a first-stage exclusion restriction stemming from a variable capturing familiarity with online payment schemes.

We investigate the mechanisms of the negative relationship between financial literacy and cryptocurrency ownership, in terms of the candidate variables that can mediate this relationship. We show that technological literacy exerts a large significant impact on cryptocurrency ownership and on the intension to own in the future. However, in models with interaction terms between financial literacy and technological literacy, the effect of financial literacy remains significant and of similar magnitude to our baseline estimates. Moreover, we examine if preference for cash can conceptually serve as a proxy for favourable attitudes to informal practices and might mediate the effect of financial literacy on cryptocurrency ownership. We find that a higher preference for cash is significantly positively related to cryptocurrency ownership and awareness, and negatively related to the intension not to own in the future. Although there is a positive effect of the interaction term between financial literacy and preference for cash on the probability to intend to own cryptocurrency in the future, the main effects of financial literacy remain robust in economic and statistical terms. We also find that cryptocurrencies are more popular among individuals younger than 45, but age is not the primary mediator of the established relationships between financial literacy and attitudes to cryptocurrencies. This is also the case for the likely mediating role of financial advice regarding cryptocurrencies[3]. The effect of financial literacy is robust in models with interaction terms between financial literacy and financial advice. There is a negative effect on cryptocurrency ownership by the interaction term between financial literacy and advice from the internet and specialist

[3] Cryptocurrency owners and prospective owners are less likely not to have any source of financial advice. The following sources of advice exert positive significant impacts on cryptocurrency ownership with the sources of higher magnitude going first: online programmes or algorithms for tailored advice, the internet and specialist websites, friends and relatives, and lastly, by an independent financial or bank advisor.

websites, signaling that the more financially literate might be better able to seek for financial information online.

Our proposed mechanism that explains the established relationship between financial literacy and attitudes to cryptocurrencies is the perception of the risk that cryptocurrencies entail, in comparison to alternative assets. We estimate models with interaction terms between financial literacy and such risk perceptions and we find significant effects of these interaction terms. Moreover, the effect of the financial literacy variable diminishes in terms of both magnitude and significance in these models. The robustness of our proposed mechanism is confirmed by the greater negative impact on cryptocurrency ownership and the intension to own in the future by the financial-risk constituent of financial literacy at the country level. It is also confirmed by a large negative effect of the interaction term between financial literacy and generic risk tolerance, approximated by the inflectional FTR of the respondent's language. We interpret our results as signaling that greater financial literacy skills, namely a more informed perception of financial risk, might be conducive to more prudent financial decision making by the more risk tolerant.

With cryptocurrencies having their own intrinsic complexities, our study presents evidence suggesting that individuals with higher financial literacy are less likely to own cryptocurrencies in their portfolio, despite displaying higher awareness about them. This is due to a more informed perception of financial risk. Our results entail implications regarding the efficiency of the cryptocurrency market. If the cryptocurrency market is be dominated by users engaging in illegal transactions and unsophisticated users, as the less financially literate in our study, then the regulators are right to be concerned about potential threats in global financial stability from the cryptocurrency markets. They should also be concerned about the financial well-being of the users of cryptocurrencies. Considering Facebook's proposal for the introduction of stablecoins, pegged to a major currency, and available to its 2.4 billion users, there should be concerns regarding the financial well-being of this major global audience and overall welfare. In addition, our results entail vast implications regarding the likely financing mode of cryptocurrency ownership. Baur, et al. (2015) posit that if Bitcoin investments are debt-financed, a significant fall in its value could lead to margin calls and then also affect other assets. Liu and Tsyvinski (2018) find that certain industries have significant exposures to bitcoin returns, both positive

(Consumer Goods and Healthcare) and negative (Fabricated Products and Metal Mining). Although the authors find no exposure of the Finance, Retail and Wholesale industries, a radical proposal such as Facebook's stablecoin in a universe of unsophisticated traders and debt-financed usage might indeed entail severe implications for macroeconomic and international financial stability.

Our study is in line with the view that more financial literate consumers in financial markets may also help to contribute to the better financial markets (Hilgert et al., 2003). Any future cryptocurrency proposal could benefit from parallel programmes that can increase both financial literacy as well as transparency in the cryptocurrency market. This is in line with a similar suggestion by Georgarakos and Pasini (2011) for promoting higher national equity ownership. Our results are in line with Liu and Tsyvinski (2018) who find that high investor attention predicts high future returns over short horizons for the Bitcoin and Ripple and medium-term horizons for Ethereum. The authors document herding effects by showing that high negative investor attention negatively predicts future Bitcoin returns. Indeed, the presentation format of financial information has been shown to affect more individuals with low skills in financial literacy (Hastings and Tejeda-Ashton, 2008; Hastings and Mitchell, 2018). In view of the evidence by Haliassos, et al. (2019) regarding exogenous peer effects and a social-multiplier effect on financial knowledge, a network dominated by largely unsophisticated users is more likely to overreact or underreact to different types of information, in the absence of fundamentals.

The remainder of this study is organised as follows. *Section 2* reviews the market for cryptocurrencies and makes the conceptual link between financial literacy and the demand for cryptocurrencies. *Section 3* presents the data, the summary statistics of the key variables and our empirical strategy. Then, *Section 4* presents the results of the estimates for the role of financial literacy on attitudes to cryptocurrencies, along with the relevant robustness tests. It also presents our inquiry regarding the main mechanisms that are likely to mediate the effect of financial literacy on the demand for cryptocurrencies. Finally, *Section 5* concludes and discusses the relevant implications of our findings.

2. Background and literature

2.1 *The market for cryptocurrencies*

Figure 1 presents the ten cryptocurrencies with the highest market capitalization for the period 2014-2019, namely the Bitcoin, Ethereum, Ripple, Bitcoin Cash, ChainLink, Litecoin, IOTA, Maker, Monero, and Dash. Their market capitalization is around $300 billion. The bitcoin solely represents more than half of this market capitalization as can be seen at the top panel of Figure 1. Their market capitalization seems to have picked in late 2017 with the market capitalization of the bitcoin exceeding $340 billion. Following the sharp decline in its price in late 2017 and early 2018, its market capitalization reached $60 billion in February 2019 and increased once more to $220 billion by July 2019. At much lower volumes, the other cryptocurrencies, and most notably Ethereum, seem to display similar patterns in terms of timing and price decline. The bottom panel of Figure 1 contrasts the top figure with figures on the market capitalization of the largest twelve S&P100 companies. The current market capitalization of the entire cryptocurrency market is just close to that of each of the bottom 6 of the top 12. Hence, the size of the cryptocurrency market is objectively small, but non negligible and with future growth potential.

[Insert Figure 1 about here]

The commonalities of cryptocurrencies can be generalized in their facilitation by technology over the internet and the likely decentralization within a network of users. Of course, the universe of cryptocurrencies is not homogenous. Some cryptocurrencies, such as Ripple, Monero, function more as payment systems due to their more effective operation structure in confirming transactions. Originally, the Bitcoin was designed for irreversible online transactions (Nakamoto, 2008). The cryptocurrency's integrated payment transfer mechanism could be thought to function as a self-standing network that does not require intermediaries. However, until today, a very limited amount of goods and services are denominated in Bitcoins, and these include the transaction costs on the Bitcoin blockchain. These are denominated in fractions of the Bitcoin, i.e. the 'Satoshis'. Bjerg (2016) posits that the Bitcoin is like '*commodity money without gold, fiat money without a state, and credit money without debt*'. Yermack (2015) posits that Bitcoin serves more as a

speculative investment than as a currency. The prevalence of massive speculative investing was also made evident during the rapid increase and decrease in cryptocurrency prices, especially in the price of the Bitcoin, during the late 2017 and early 2018.

The supply of the Bitcoin is exogenous and pre-determined to be restricted to 21 million Bitcoin units. The miners are compensated by Bitcoins for transfer verification written on a block on the blockchain and for transfer fees. The miners use resources such as electricity to mine or verify transactions on the Bitcoin blockchain (Nakamoto, 2008). A new block containing on average two thousand transactions, is mined every 10 minutes and for each the miner will be compensated with 12.5 Bitcoins. In total, up to 1,800 new Bitcoins are produced each day until the estimated 2020. After this, the number of Bitcoin compensation to miners will half further and represent 6.25 Bitcoins per a block. Due to the increase of specialist mining rigs on the Bitcoin network, the chances of a normal user to be able to mine blocks is much reduced. Hence, it can be asserted that the average cryptocurrency users are more likely to attain their exposure through initial coin offerings (ICOs) or through various cryptocurrency exchanges rather than through mining. Even if the cryptocurrencies are largely designed to be decentralized, exchanges may have a certain influence on the volume and price, which denotes some centralization of market power. Indeed, the third-party service providers, such as the cryptocurrency exchanges have seen acting to impact the Bitcoin price (e.g. Brandvold, et al., 2015).

Figure 2 presents the price development of the bitcoin for the period between 2016-2019, compared to other asset classes, namely gold, real estate, sovereign bonds, equities, and cash. The price of the bitcoin reached that of gold in March 2017 for the first time and then the rally began, with the price of the bitcoin reaching $19,000 in December 2017, with that of gold remaining close to $1,250. The bottom panels of Figure 2 show that the remaining asset classes exhibit far more stable prices than that of the bitcoin, with the exception of equities, which have witnessed an increase from $100 in January 2016 to $210 in August 2018, and then a decrease to $170 by January 2019.

[Insert Figure 2 about here]

Hence, the consensus at present seems to be that cryptocurrency is perceived as an asset, rather than as currency (e.g. European Union, 2018)[4]. Traditionally assets are valued for their future revenue stream or the intrinsic utility that commodities entail. Financial instruments are considered to hold no intrinsic utility value and are essentially a claim on borrower's future income or assets. Cryptocurrency may be thought to hold a utility through its own decentralized and self-governing system that can provide a medium of exchange and a function that can store value. Their lack of traditional financial fundamentals makes their value complex to calculate[5]. The Bitcoin blockchain system by design does not entail future cashflows or interest, except for miners' compensation for verifying transactions. The lack of attention to fundamentals can motivate investors to participate in speculative price increases, such as that witnessed in the Californian real estate market in the late 1880s (Shiller, 1990). In a similar fashion, the limited supply feature and the related scarcity element may have contributed to the sudden increase in the price of the Bitcoin during the period between the late 2017 and early 2018.

In standard financial instruments, scalability can make the services cheaper. In contrast, it seems that the more popularity of the Bitcoin made the transactions more expensive. This has largely been seen as difficulty of the Bitcoin network's ability to scale up and function as a payment system. However, its scarcity and non-scalability made it to be perceived more as a store of value, which can serve as a substitute to fiat money in situations of crisis or in regions of low financial inclusion, high currency volatility and/or low trust in financial institutions[6]. Nevertheless, when cryptocurrencies were compared to

[4] Analyzing the functions of money, Jevons (1875) concluded that money allows utilities such as a medium of exchange, a measure of value, a store of value and a standard of deferred payment. Intuitively, money facilitates the exchange of goods and services through its sought characteristics for 'portability', 'indestructibility', 'homogeneity', 'divisibility', 'stability of value' and 'cognizability'. Shiller (2018) discusses the difficulty of applying technological advancements to substitute money citing the proposal to the Econometric Society during the years of the Great Depression (i.e. in 1932), by John Pease Norton, a former student of Irvin Fisher, for a dollar backed not by gold but by electricity. Despite the attention the proposal received in years of deflation and lack of liquidity, it lacked in a good reason for choosing electricity over other commodities to back the dollar.

[5] For instance, Brainard et al. (1990) view fundamentally based returns of equities as the firm's cash flow after tax net depreciation divided by the net replacement cost of its assets. During the early 2000's, the newly founded technology companies with no or low levels of cashflows, and having other valuation challenges, saw high equity price increases that was seen to be fueled by sentiment-driven investing of retail investors (Baker and Wurgler, 2007).

[6] The demand of the Bitcoin seems to have surged during events such as the banking crisis of Cyprus in 2013 (Forbes, 2013) and the political unrest in Zimbabwe in 2017 (Telegraph, 2013). Moreover, following

the currencies of the least developed countries between 2014 and 2017, were shown to entail more volatility (Kasper, 2017), with the Bitcoin being the most volatile cryptocurrency (Baur and Dimpfl, 2017). The top panel of *Figure 3* presents daily one-month running annualized volatilities for the bitcoin and selected asset classes, namely gold, real estate, sovereign bonds, equities, and cash. It is evident that the volatility of the bitcoin is several times that of stocks, gold, real estate, and bonds[7]. The bottom part of the figure presents the corresponding volatilities in comparison to some international currencies, i.e. those of the counties in our study, namely the Polish Zloty, the Romanian Leu, the Turkish Lira, the Euro, the Australian dollar, the British pound, the US dollar, and the Czech Koruna. It is only the Turkish Lira that has exhibited higher volatility than the Bitcoin in the period between July-September 2018, and once again, the volatility of the bitcoin is much higher than that of all currencies.

[Insert Figure 3 about here]

While the complex information on the production, mining, technology, circulating and maximum supply of the bitcoin and other cryptocurrencies is available to current and prospective users, much less is known regarding the demand side. Such information is essential for price determination (Ciaian et al., 2016)[8]. If the demand for cryptocurrencies, such as the bitcoin, is unpredictable, it is difficult to forecast the future value and usage of the bitcoin (Baur, et al., 2015). Garcia, et al. (2014), suggested a low bound to a fundamental price by taking into account the cost of electricity interaction, sentiment and user adaption reinforcement. Indeed, Kristoufek (2013) posited that a crucial driver of the

2014, hyperinflation in Venezuela and the creation of their own Petro cryptocurrency, along with Gresham's Law, also increased the demand of the Bitcoin (Time, 2018). Furthermore, anecdotal evidence suggests cryptocurrency usage among refugees is high, providing transport security and facilitating remittances. The public dialogue has seen arguments emphasizing on the future potential of the blockchain technology facilitating functions among refugee communities, including financial inclusion and remittances (Flore, 2018; Forbes, 2019).

[7] The *Appendix Table A1* calculates the standard investment risk and return characteristics of the Bitcoin, in terms of the Sharpe and Sortino ratios. The Bitcoin's volatility nearing 90% is compensated by higher returns during the 3-year period 2016-2018. However, in 2018, this high volatility corresponds to very large negative returns, much higher compared to the remaining asset classes. When one takes into account a nominal risk-free rate. The bitcoin entails the largest negative Sortino ratio for the year 2018, compared to real estate and the remaining asset categories.

[8] Böhme et al. (2015), Dwyer (2015) and Yermack (2015) present early introductions to the economics of the Bitcoin.

Bitcoin's price is mere sentiment-driven speculation, as sentiment is a key driver of most retail-investor phenomena (Barber and Odean, 2008). Liu and Tsyvinski (2018) find that there is a strong time-series momentum effect in cryptocurrency markets, with returns being predicted by factors that are specific to cryptocurrency markets. Importantly, proxies for investor attention strongly forecast cryptocurrency returns. Bianchi and Dickerson (2019) point out that the relation between volume, current and future returns depends on the relative significance of hedging versus speculative trade, as well as on the aggregate balance of informed vs. uninformed traders. The authors highlight the presence of highly heterogeneous market participants, e.g. miners, individual traders, and large-scale investors. Rooney and Levy (2018) point out to the emergence of some 300 'cryptofunds', which managing some $10 billion in assets. Importantly, Foley, et al. (2019) estimate that some 46% of bitcoin transactions are related to illegal activity. Finally, Glaser, et al. (2014) assert that uninformed users are attracted to digital currencies as an alternative investment vehicle, rather than as an alternative transaction system. Thus, apart from miners, there seem to be three dominant types of cryptocurrency users, i.e. large 'cryptofunds', illegal traders, and uninformed users or unsophisticated investors.

2.2 *Could financial literacy be relevant to the demand for cryptocurrencies?*

Some of the key puzzles in individuals' asset allocation involve low stock market participation, under-diversification, poor trading performance, and investment in actively managed and costly mutual funds (Beshears, et al., 2018). It is obvious that investment in the cryptocurrency market can be linked to the latter three puzzles, and it is not yet clear if the figures for cryptocurrency-market participation are similar to these for stock market participation[9]. However, there are potential inferences for the market for cryptocurrencies from the literature on stock market participation. For instance, individuals expecting higher stock market returns are more likely to participate in stock markets (Hurd, et al., 2011; Kezdi and Willis, 2011), while those who believe that other market participants might cheat them out of their investment will perceive lower expected returns and be less willing to participate (Guiso, et al. 2008). Greenwood and Nagel (2009) conclude that less

[9] Guiso and Sodini (2013) find that only half of US households participate in the stock market. In several European counties, e.g. Greece, Italy, Spain, and Austria, the participation rates are below 10%.

experienced and younger investors are more likely to participate in over-priced asset investing due to the lack of previous investing experience. Mistakes in investing are likely to take place when a new financial asset is introduced (Campbell, 2009)[10].

Recent literature has linked financial literacy with avoiding financial mistakes and engaging in prudent financial behaviour, e.g. formal financial market participation (Klapper, et al., 2013) stock market participation (van Rooij et al., 2011; Almenberg et al., 2011)[11] and the frequency of stock trading (Graham, et al., 2009), negotiation of debt terms and repayment patterns (Moore, 2003; Campbell, 2006; Lusardi and Tufano, 2009a; b), levels of debt and default (Stango and Zinman, 2009; Gerardi et al. 2010), and retirement planning (Klapper and Panos, 2011; Lusardi and Mitchell, 2011a; b; c). The analysis in Lusardi, et al. (2017) indicates that financial literacy, acquired early in life and becoming endogenous to financial decisions around the lifecycle, can explain some 35-40% of retirement wealth inequality in the USA. Part of this could possibly be explained via the improved ability by individuals to hold and trade stocks and effectively manage portfolios involving risky assets through diversification (e.g Calvet et al., 2007; Christiansen, 2008; von Gaudecker, 2015, Bianchi, 2018)[12]. The ability of individuals to assess financial risk and make optimal financial decision entails vast implications for the portfolio allocation, wealth accumulation (Behrman, et al., 2012), and ultimately financial well-being.

Could the market for cryptocurrencies attract individuals with low financial literacy? Should we expect the financially literate to be in favour or against ownership and

[10] For instance, during the dot.com bubble in the late 1990s, higher participation rates were seen among the inexperienced younger investors (Greenwood and Nagel, 2009). These newly IPO'ed technology stocks were difficult to be valued for their e.g. non-existent revenues and opaque growth type characteristics. Due to the lack of fundamentals, the prices were seen to be driven by sentiment-induced trading by the majority of the retail investors.

[11] van Rooij et al. (2011) report a certain lack of understand among retail investors about the differences between equities and bond investments, and a greater propensity to invest in the stock market. Christelis et al. (2010) also propose that higher cognitive abilities are related to the direct stock ownership.

[12] Indeed, greater financial illiteracy has been linked with more portfolio under-diversification (e.g. von Gaudecker, 2015; inter alia). Nearly all households that score high on financial literacy or rely on professionals or private contacts for advice achieve reasonable investment outcome, and all group differences stem from the top of the loss distribution. Bianchi (2018) finds that more financially literate households hold riskier positions when expected returns are higher, they more actively rebalance their portfolios and do so in a way that holds their risk exposure relatively constant over time, and they are more likely to buy assets that provide higher returns than the assets that they sell. In addition, Choi, et al. (2010) and Duarte and Hastings (2012) relate financial literacy with choosing a low-fee investment portfolio.

prospective ownership of cryptocurrencies, such as the Bitcoin? The literature has already pointed out that the market is dominated by 'illegal traders' and 'cryptofunds'. Wang (1994) and Llorente et al. (2002) show that trades based on private information are mimicked by uninformed investors, resulting in return continuations following high volume and price reversals following low-volume periods. If the more financially literate are more likely to participate in stock markets, have a more diversified asset portfolio and obtain higher asset returns, it is likely that they will also be more likely to engage in the cryptocurrency market. On the other hand, if the more financially literate are better positioned to assess financial risk, minimize financial decisions based on imitation and sentiment, and/or overcome or avoid the formation of mistaken beliefs and expectation of constantly high returns, then they might be less likely to engage in the market for cryptocurrencies. Indeed, low financial-literacy has been associated with mistaken perceptions and beliefs about financial products and less willingness to accept financial advice (Anderson, et al., 2017).

Hence, our primary research question is whether the more financially literate are more likely to own or intend to own cryptocurrencies, or not. Our secondary set of research questions involves the mediating factors in any relationship between financial literacy and cryptocurrency ownership. As we previously highlighted, these can involve technological literacy, younger age, preference for cash and informal practices, and financial advice[13]. Intuitively, they could involve a more 'enlightened' understanding of the risk and reward prospects of cryptocurrencies. Indeed, evidence from financial literacy surveys around the world indicates that the financial risk concept is the most difficult for respondents to contextualize and respond correctly to (Lusardi and Mitchell, 2014; Montagnoli, et al., 2019).

[13] Collins (2012) shows that financial literacy and financial advice are complementary rather than substitute. For instance, if the more financially literate have access to better financial information and financial advisors (Calcagno and Monticone, 2015; Stolper, 2018), then it could be the case that optimal financial advice drives the relationship between financial literacy and attitudes to cryptocurrencies, rather than knowledge per se.

3. Data and Empirical Strategy

3.1 *The Data*

We utilize the ING 2018 International Survey on Mobile Banking[14]. The survey was conducted between 26th March and 6th April 2018 by Ipsos International[15]. The data collection took place in 15 countries, namely the United States, Australia, Austria, Belgium, France, Germany, Italy, Luxembourg, the Netherlands, Spain, the United Kingdom, the Czech Republic, Poland, Romania, and Turkey. Around 1,000 people were surveyed in each country, with the only exception of Luxembourg, in which 500 individuals were interviewed. The sampling is representative of gender ratios and the age distribution, selecting from pools of possible respondents furnished by panel providers in each country. In addition, sampling weights are provided by the data collectors to render the data representative of the population by country. The final sample comprises of some 14,828 adult respondents who were interviewed by phone and through the internet[16]. In our analysis, we drop some 90 respondents with no educational qualification, and another 156 respondents who were aged more than 75 at the time of the interview. Our resulting sample comprises of 14,582 individuals, 49% of which are male, with an average age of 44.5 years. 51% are married, 44% are employed full-time, 11.3% are employed part time, and 6.1% are self-employed. 21.8% have a higher degree, and 14.1% have a postgraduate university degree. The average household income per capita (PPP-divided) is €1,116 per month and there are missing income observations for 10.7% of the sample.

The ING International Survey inquired about how cryptocurrencies, such as the Bitcoin, are perceived across Europe, the USA and Australia. The surveyors defined cryptocurrency as a type of digital currency not created or secured by the government but by a network of individuals. The question that enables the depiction of attitudes to cryptocurrencies was the following: "*Have you ever heard of cryptocurrency? If so, do you own any?*". The response categories involved: (a) I have heard of cryptocurrency; (b) I own

[14] The data and documentation are available upon request to the data collectors at Ipsos.

[15] The survey took place shortly after a period of rapid increase and then a sharp decrease in the prices of several cryptocurrencies, most notably the Bitcoin, during late 2017 and early 2018.

[16] This approach is seen as likely to entail less sampling bias, compared to only interviewing respondents who are connected to the internet (Chang and Krosnick, 2003).

some cryptocurrency; (c) I expect to own cryptocurrency in the future. The grid options for each of the three items involved: (I) Yes, and; (II) No. As a result, the wording of the question enables the generation of a categorical variable for attitudes to cryptocurrencies entailing four categories, namely: (1) Owning cryptocurrencies at present; (2) Expecting to own cryptocurrencies in the future; (3) Not expecting to own cryptocurrencies in the future, and; (4) Not having heard of cryptocurrencies before.

3.2 *Attitudes to cryptocurrencies*

Figure 4 presents the frequencies of responses to our main question regarding attitudes to cryptocurrencies, overall and for each of the 15 counties in our sample. Weighted summary statistics are shown for the four categories of responses, i.e. owning cryptocurrencies, not owning but intending to own, not owning and not intending to own, and not having heard of cryptocurrencies. The bars indicate that 8.7% of the overall sample own some cryptocurrency. 13.3% do not own but intend to own in the future. Some 43% of the sample do not own and do not intend to own cryptocurrency. The remaining 34.5% have never heard of cryptocurrency before. The figure of ownership is 8.2% in the USA and 6.6% in Australia. In the USA 11.4% of the sample intends to own cryptocurrencies and 38.1% does not intend to own in the future. The corresponding figures for Australia are 8.9% and 55.2%, respectively. 42.3% of the US sample has never heard of cryptocurrencies, with the figure for Australia being notably lower, i.e. 29.4%.

[Insert Figure 4 about here]

The figures for ownership and intension to own are notably high among the *ECA* countries in our sample, i.e. Turkey, Romania, the Czech Republic, and Poland. The latter three counties are among the newest member counties in the European Union. A striking 17.4% if the sample in Turkey own some cryptocurrency, with an additional 24.2% not owning but intending to own. The figures for not intending to own and not having hears of cryptocurrency in Turkey are 28.7% and 29.6% respectively. The high figures of ownership and intension to own cryptocurrency can be related to uncertainty stemming from the recent high volatility in the Turkish lira, which is also evident in the second panel of Figure 3. In Romania, some 12.5% of respondents own cryptocurrencies, with another 23.9% intending

to own in the future. 38.3% do not intend to own and a remaining 25.3% have never heard of cryptocurrencies. In the Czech Republic, the figures for the four categories are 9.1%, 10.5%, 50.5%, and 29.9%, respectively. In Poland, 11.5% of the sample own some cryptocurrency, with an additional 18.1% intending to own in the future. Some 47.8% do not intend to own, and a rather small figure of 22.7% have never heard of cryptocurrencies.

In the United Kingdom, only 6.5% of the sample owns cryptocurrencies, with an additional 8.8% intending to own in the future. The figures are similar to those for Australia. 47.1% of the UK sample does not intend to own cryptocurrencies in the future, and some 37.7% have never heard about them. Among the remaining older member counties of the European Union, the figures for ownership (and intension to own) are: a rather high 10.3% (18.1%) in Spain, 7.4% (6.6%) in the Netherlands, 4% (9.1%) in Luxembourg, 7.9% (17.1%) in Italy, 8.1% (13.6% in Germany), 6% (10.2%) in France, 4.7% (5.4%) in Belgium, and 8.5% (11.1%) in Austria. 30% of the Spanish respondents has heard but does not intend to own cryptocurrencies in the future. The figures for negative inclination towards cryptocurrencies in the remaining old EU counties are: 41.3% in the Netherlands, 54.5% in Luxembourg, 45.5% in Italy, 49.5% in Germany, 34.9% in France, 28.4% in Belgium, and 59.9% in Austria. Finally, the fraction of individuals who have never heard of cryptocurrencies are 32.6% in Spain, 44.7% in the Netherlands, 32.4% in Luxembourg, 29.5% in Italy, 28.9% in Germany, a high 48.9% in France, a striking 61.5% in Belgium, and some 20.5% in Austria.

Consequently, the ING survey results on cryptocurrency ownership corroborate surveys conducted through the internet by YouGov in the UK and USA, and by Dalia Research in the US, UK, and Germany (Yougov, 2018a; b; 2019; Rauchs, et al., 2018; Jakubauskas, 2018). The latter also report figures for Brazil, Japan, South Korea, China and India. However, the ownership and awareness shares of a sample differ more from the face-to-face based survey conducted by the FCA UK in the mid December in 2018 (Financial Conduct Authority, 2019)[17].

[17] The *Appendix Figures A1 and A2* present the demographic composition of our attitudes to cryptocurrencies. Each bar of the Appendix Figure A1 presents a decomposition of all four attitudinal variables by gender, overall and, then, for each of the 15 counties in our sample. Evidently, males are more likely to own cryptocurrencies and less likely not to have heard about them. This pattern exists in

3.3 *Empirical Strategy*

Departing from the notable variation in the figures towards attitudes to cryptocurrencies across counties, we examine the relationship between financial literacy and attitudes to cryptocurrencies in regression analysis. Then, we also examine the specifics of this relationship, in terms of the mediating factors. The ING 2018 International Survey on Mobile Banking did not include specific questions regarding financial knowledge. Hence, we generate an external proxy for financial literacy for the individuals in our sample, based on their individual demographic and country profile. We merge individuals in our sample, with disaggregated financial-literacy figures from the Standard & Poor's Ratings Services Global Financial Literacy Survey[18]. The merging is conducted based on country figures by gender, age group (15-34, 35-54, ≥55), and income group (top 60%/bottom 40%)[19].

The survey included five financial literacy questions covering the four fundamental financial concepts, i.e. interest (numeracy), interest compounding, inflation (money illusion), and the understanding of financial risk (Klapper et al., 2015). The disaggregated financial literacy figures we utilize measure the probability of an individual of a given gender, age and income group in a given country to know at least 3 out of 4 concepts, by

all counties in our sample. Similar lower participation eates by females have been seen in equity investment (e.g. van Rooij at al., 2011) and other risky-asset investment (Almberg and Dreber, 2015). In the *Appendix Figure A2*, it is shown that the young are more likely to own cryptocurrencies and to intend to own in the future. The old are more likely not to intend to own in the future. Similar higher participation rates were seen among the younger investors during the dot.com stock investing boom in the late 1990s (Greenwood and Nagel, 2008). The educated are more likely to own cryptocurrencies and less likely not to have heard about them. The self-employed and the employed are more likely to own cryptocurrencies, and the inactive and the unemployed are the groups more likely not to have heard about them. Respondents in higher income groups are more likely to own cryptocurrencies, less likely not to have heard about them. However, they are also the groups that are more likely not to intend to own cryptocurrencies in the future.

[18] The Standard & Poor's Ratings Services Global Financial Literacy Survey is the world's largest and most comprehensive global measurement of financial literacy. It probes knowledge of four basic financial concepts: risk diversification, inflation, numeracy, and interest compounding. The survey is based on interviews with more than 150,000 adults in over 140 countries. The survey was implemented in 2014, as a collaboration between McGraw Hill Financial Gallup, Inc., the World Bank Development Research Group, and the Global Financial Literacy Excellence Centre.

[19] The disaggregated statistics by country, for each of the 4 constituent concepts of financial literacy in each country, and by gender, age and income group in each country for the selected 15 counties in our sample are shown in the Appendix Table A2. Data for all counties in the S&P Global Financial Literacy Survey are publicly available at: https://www.cssf.lu/fileadmin/files/Protection_consommateurs/Education_financiere/SP_Ratings_Global_FinLit-Summary_Statistics_as_of_12152015.xls

answering correctly to the related questions[20]. Our primary financial-literacy proxy is the average score by gender, age, and income in each country. We get 300 distinctive financial-literacy profiles, i.e. 15*2*3*2, for the individuals in the ING 2018 International Survey.

Figure 5 presents scatterplots for the four response categories in the attitudes to cryptocurrencies, with financial literacy at the county level at the horizontal axis. The four scatterplots indicate a modest negative relationship between financial literacy and ownership of cryptocurrencies, and a stronger negative relationship between financial literacy and the intension to own cryptocurrencies in the future. At the bottom two scatterplots, there is a stronger positive association between financial literacy and the negative inclination towards ownership of cryptocurrencies in the future. There is also a positive association between financial literacy country scores and the likelihood to have heard of cryptocurrencies. At the left-hand side of all four scatterplots are Romania and Turkey, with low financial literacy county scores and higher cryptocurrency rates for ownership and inclination to own. At the very right of all scatterplots are Australia, Germany, the United Kingdom, and the Netherlands, with high financial-literacy country scores and low ownership and inclination-to-own rates.

Insert Figure 5 about here]

Following the indicative figure shown, based on country-level scores of financial literacy, we depart in examining the relationship between financial literacy and attitudes to

[20] The exact wording of the questions was: (1) Risk diversification: "*Suppose you have some money. Is it safer to put your money into one business or investment, or to put your money into multiple businesses or investments?*". The response categories were: (i) *one business or investment*; (ii) *multiple businesses or investments*; (iii) *I don't know*; (iv) *refused to answer*. (2) Inflation: "*Suppose over the next 10 years the prices of the things you buy double. If your income also doubles, will you be able to buy less than you can buy today, the same as you can buy today, or more than you can buy today*"? The response categories were: (i) *less*; (ii) *the same*; (iii) *more*; (iv) *I don't know*; (v) *refused to answer*. (3) Numeracy (interest): "*Suppose you need to borrow 100 US dollars. Which is the lower amount to pay back 105 US dollars or 100 US dollars plus three percent*"? The response categories were: (i) *105 US dollars*; (ii) *100 US dollars plus three percent*; (iii) *I don't know*; (iv) *refused to answer*. (4a) Compound interest I: "*Suppose you put money in the bank for two years and the bank agrees to add 15 percent per year to your account. Will the bank add more money to your account the second year than it did the first year, or will it add the same amount of money both years*"? The response categories were: (i) *more*; (ii) *the same*; (iii) *I don't know*; (iv) *refused to answer*. (4b) Compound interest II: "*Suppose you had 100 US dollars in a savings account and the bank adds 10 percent per year to the account. How much money would you have in the account after five years if you did not remove any money from the account*"? The response categories were: (i) *more than 150 dollars*; (ii) *exactly 150 dollars*; (iii) *less than 150 dollars*; (iv) *I don't know*; (v) *refused to answer*.

cryptocurrencies at the individual level. We estimate weighted multinomial probit regressions (McFadden, 1989) for attitudes to cryptocurrencies, using a proxy for financial literacy at the individual level as our main explanatory variable. We also utilize a rich set of control variables for individual characteristics in our specifications. We estimate specifications of the following form for attitudes to cryptocurrencies:

$$AC_i = \beta_1 (FL_i) + \beta_2 X_i + \theta_r + \varepsilon_i, \quad (1)$$

where: AC_i is a 4-category variable capturing attitudes to cryptocurrencies for individual i, FL_i is a variable capturing financial literacy, X_i is a vector of individual characteristics, θ_r is a fixed effect for country of residence and ε_i is the usual error term.

3.4 *Main control variables and related summary statistics*

The list of control variables in the vector X_j includes demographic characteristics, namely gender, a 3rd order polynomial in PPP-divided household income per capita, 6 age-group dummy variables, 4 dummy variables for marital status, a household size variable, 5 dummy variables for the level of education, and 7 dummy variables for occupational status. In addition, we generate three additional variables capturing technological literacy, preference for cash, and the future-tense orientation of the respondent's language (hereafter inflectional FTR). Moreover, we generate variables for the perceptions of the reward and risk involved in cryptocurrencies. These variables, which entail proxies for the factors that could mediate the effect of financial literacy on attitudes to cryptocurrencies, are described in detail in the following sub-section.

Table 1 presents our primary list of explanatory variables and their weighted summary statistics. The figures are presented overall (Column 1), for individuals who own cryptocurrencies (Column 2), for individuals who do not own but intend to own in the future (Column 3), for respondents who do not intend to own cryptocurrencies in the future (Column 4), and for individuals who have never heard of cryptocurrencies (Column 5). Column 6 presents the difference in the figures between individuals who own or intend to own cryptocurrencies and those who do not intend to own or have never heard of

cryptocurrencies, along with a weighted t-test for differences in averages[21]. The table shows that our financial-literacy proxy, which captures the probability to know at least 3 out of 4 financial literacy concepts, entails lower figures along individuals owning and intending to own cryptocurrencies, compared to individuals who do not intend to own or have never heard of cryptocurrencies. This observation matches well with the scatterplots for attitudes and country-level scores in Figure 5. The mean difference between these two greater groups is negative and statistically significant at the 1% level.

[Insert Table 1 about here]

In terms of demographic characteristics, the average PPP-divided monthly household income per capita in the sample is €1,116.4, with owners and prospective owners of cryptocurrencies being poorer by some €140 per month on average. Individuals intending to own cryptocurrencies in the future have some €237 per month lower income, compared to individuals who have heard but do not intend to own cryptocurrencies. 49% of the sample are males, with 68.2% of and 60.6% of prospective owners being males. 32.4% of those who have never heard of cryptocurrencies are males. The average age in the sample is some 44.5 years old, with the sample of owners and prospective owners being significantly younger. The average age among owners is 38.5 years, and the figure for prospective owners is 38.9 years. The average age for those not intending to own is 46.7 years, and it is 45.3 years of age for those who have never heard of cryptocurrencies. 51% of the sample are married, 21.4% are single, 16.4% are in a relationship, and 11.3% are widowed or divorced/separated.

3.5 *Proxies for mediating factors and related summary statistics*

Firstly, we compute a variable capturing technological literacy, as the number of items owned among the following: (1) Smartphone; (2) Tablet; (3) Smart TV; (4) Mobile phone (but not a smartphone); (5) Wearable device (such as an Apple Watch). This is converted into an index via dividing by 5. The figures in Table 1 indicate that individuals owning and intending to own score higher in terms of technological literacy, compared to

[21] The weighted t-test is computed via the parmby and metaparm commands in Stata (Newson, 2008).

individuals who do not intend to own or have never heard of cryptocurrencies before. Individuals who who are more competent with technology can be thought as more likely to be aware of cryptocurrencies, as well as the underlying technology that supports them. For instance, Giudici et al. (2018) study the success rates of Initial Coin Offerings (ICOs) and find that the availability of their source code is positively and significantly associated with reports of successful asset raising.

Secondly, we also generate a variable capturing preference for cash and measured as the number of items, usually paid for in cash, among the following: (1) Rent/mortgage; (2) Utilities (e.g. electricity, gas); (3) Lunch/coffee/snack; (4) Regular (weekly) grocery/food shopping; (5) Restaurant; (6) Public transport (subway, bus); (7) Taxis; (8) Gifts; (9) Pocket money; (10) Lending money to friend or family member. Then, this is converted into an index via dividing by 10. We consider the preference for cash as indicative of a certain tendency towards informal practices and payments. Rogoff (2016) points out that cash is also largely anonymous, i.e. it can only be traced through large serial numbers, and it has traditionally played an important role in facilitating crime and illegal trade. Hence, a higher preference for cash might be thought of as a proxy for inclination to informal practices and payments. In Table 1, owners and prospective owners of cryptocurrencies score higher in the preference for cash, compared to those negatively inclined or ignorant about cryptocurrencies. While this significant mean difference could be driven by the younger or the more technologically literate, the lower figure for preference for cash among those who have heard but do not intend to own cryptocurrencies could be indicating a positive correlation between cryptocurrency and inclination to informality.

Thirdly, we generate a variable for risk tolerance or generic preference for risk, captured via the future time-reference of the respondent's language (hereafter *inflectional FTR*). The inflectional FTR data for the languages in our sample are provided in Chen (2013)[22]. He finds that the languages that grammatically associate the future and the present foster future-oriented behaviour and shows that speakers of such languages exhibit less risky behaviour, i.e. save more, retire with more wealth, smoke less, practice safer sex, and

[22] Languages where verbs have distinct future forms are said to have an "inflectional" future. The original source data on inflectional futures is from Dahl (1985) and Dahl and Velupillai (2011).

are less obese. The inflectional FTR is a dummy variable taking the value 1 for 4 out of 11 languages in the ING 2018 International Survey, namely French, Italian, Spanish, and Turkish. The remaining 7 languages, namely German, English, Luxembourgish, Dutch, Polish, Romanian, and Czech, take the value 0. The figures in Table 1 indicate a significantly higher inflectional FTR among owners and prospective owners of cryptocurrencies, compared to the remaining sample, i.e. the future time-reference of respondents' language is higher among those owning and intending to own cryptocurrencies.

Fourthly, we generate a set of proxies for the sources of financial advice on investment and cryptocurrencies Individuals who had heard of cryptocurrencies before were presented with the following question: '*If you had money available (about 1 month's take-home/net pay) and you wanted some more information on cryptocurrency as a possible investment, where would you most likely get advice'?* The response options involved the following categories: (1) An independent financial advisor or bank advisor; (2) My friends/My family; (3) The internet and specialist websites; (4) An online computer program or algorithm that provides tailored advice; (5) I (would) never invest money in cryptocurrency; (6) I don't know. Intuitively, individuals with higher financial literacy is more capable to assess the quality of financial advice. Hence, it could be the case that financial advice on cryptocurrencies could be mediating any effect of financial literacy to the demand for cryptocurrencies. These questions were asked to the sub-sample of the 9,538 individuals who had heard of cryptocurrencies before.

Advice from friends and family had been described to be an informal source of investment information (Stolper and Walter, 2017). Evidence suggests that individuals are more likely to initiate stock market investment if their neighbours have recently experienced good returns[23]. On the other hand, Chaliassos, et al. (2019) find that exogenous exposure to more financially literate neighbours promotes saving in private retirement accounts and stockholding, primarily for educated households and via substantial

[23] In a field experiment, Bursztyn, et al. (2014) show that apart from the learning effect, such peer effects can arise because one's utility of owning an asset is directly affected by whether a peer owns the asset, due to relative wealth considerations or the pleasure of being able to talk about a commonly held investment.

interaction and knowledge transfer possibilities. Previous literature has shown that the more financially literate are better able to seek for appropriate financial advice on financial matters (e.g. Calcagno and Monticone, 2015; Stolper, 2018). Hilgert, et al. (2003) find that households with higher financial practice index scores hold a preference on sourcing information on financial service over the internet than other media outlets.

In terms of access to financial advice, 19.2% of the sample would receive financial advice for investment in cryptocurrencies from an independent financial advisor or bank advisor, 7.8% would receive such advice from friends and family, 26.6% would receive advice on cryptocurrencies from the internet and specialist websites, and 6.4% would utilise an online computer program or algorithm for tailored advice on investment in cryptocurrencies. A remaining 40% of the sample would not receive financial advice or would not know where to look for financial advice on cryptocurrencies. There are notable differences between owners/prospective owners of cryptocurrencies and the rest, in terms of the likelihood to use the internet and specialist websites for financial advice. Moreover, owners and prospective owners are significantly less likely not to use any financial advice or not to know where to seek for financial advice, compared to those who do not intend to own or who have never heard of cryptocurrencies.

Fifthly, we generate proxies for the perceptions of reward and risk of investment in cryptocurrencies. There were two specific questions in the 2018 ING Mobile Banking survey that enable the examination of this mechanism. These questions were asked to the sub-sample of the 9,538 individuals who had heard of cryptocurrencies before. Our reward proxy originates in the following question: "*Crypto-money or cryptocurrency is a kind of digital currency. This currency is not created nor secured by the government, but by a network of individuals. Bitcoin is the best-known example. Please indicate how much you agree or disagree with the following statements*":

- "Digital currencies – such as Bitcoins – are the future of spending online".
- "Digital currencies – such as Bitcoins – are the future of investment as storage of value".
- "I think the value of digital currencies – such as Bitcoins – will increase in the next 12 months".

We transform the order of the six grid options offered for each item in the original survey, so that responses signify: (1) Strongly disagree; (2) Disagree; (3) Neither agree or

disagree/I don't have an opinion; (4) Agree; (5) Strongly agree[24]. In Table 1, the perceptions of reward are notably higher among owners and prospective owners of cryptocurrencies, compared to the rest. Owners and prospective owners of cryptocurrencies are significantly more likely to believe that digital currencies, such as the Bitcoin, are the future of spending online, the future of investment as storage of value. Moreover, noting that the survey took place in mid-2018, they are more likely to believe that the value of digital currencies, such as the Bitcoin, will increase in the next 12 months, compared to individuals who do not intend to own or have never heard of cryptocurrencies[25].

Finally, our proxy for the perception of the risk of cryptocurrencies stems from the following question: "*Cryptocurrencies are a type of asset. How would you compare the risk of owning cryptocurrency compared to the following alternative assets*"?

- Cash
- Government bonds
- Stock market investment
- Real estate / property funds
- Gold
- Investing in your own business

We transform the order of the five grid options offered for each item, so that responses signify the following: (1) Holding cryptocurrency entails much lower risk compared to holding … [the alternative asset]; (2) Holding cryptocurrency entails lower risk compared to holding …; (3) Holding cryptocurrency entails about the same risk as holding …; (4) Holding cryptocurrency entails higher risk compared to holding …; (5) Holding

[24] The ***Appendix Figure A3*** presents in bars the frequencies of responses for each of the three statements. Panel A presents the frequencies of each of the five categories. Panel B presents the percentage of individuals who strongly agree or agree with each of the three statements. Weighted frequencies are presented overall and by country. Overall less than a third of the sample agree or strongly agree with the view that digital currencies are the future of spending, the future of investment as storage of value, and with the view that their value will increase in the next 12 months. It is also the case that about one third of the overall sample strongly disagrees or agrees with each of the statements. About 40% of the sample neither agrees or disagrees or has no view on the prospects of cryptocurrencies. In Panel B, it is worth noting that individuals in Australia, the Netherlands, Luxembourg, Austria and Belgium appear more skeptical regarding the prospects of cryptocurrencies in all three aspects.

[25] In the ***Appendix Table A3***, we also compute the summary statistics of Table 1, distinguishing between individuals of high and low financial literacy within each country, i.e. those for which the percentile of the financial literacy score is greater or lower than the 50th percentile within each country. It is shown that the high literate group within each country has lower scores on all 5 reward perceptions of cryptocurrencies. These associations are also confirmed in the weighted pairwise correlation matrix in the ***Appendix Table A4***.

cryptocurrency entails much higher risk compared to holding … [the alternative asset].[26] In Table 1, it is shown that, compared to the rest of respondents, owners and prospective owners of cryptocurrency are significantly less likely to believe that cryptocurrencies, such as the Bitcoin are riskier than all cash, bonds, stocks, real estate/funds, gold, and investment in one's own business[27].

4. Financial literacy and attitudes to cryptocurrencies

4.1 Does financial literacy affect the demand for cryptocurrencies?

Table 2 presents our baseline estimates of the relationship between financial literacy and attitudes to cryptocurrencies. Marginal effects and robust standard errors are shown in brackets for the four response categories of our dependent variable, namely owning cryptocurrencies (Column 1), not owning but intending to own in the future (Column 2), not owning and not intending to own in the future (Column 3), and not having heard of cryptocurrencies before (4). The estimation method is a weighted multinomial probit regression. The error terms are assumed to be independent, standard normal, random variables. The multinomial probit model is the suitable model to estimate for attitudes to cryptocurrencies. Compared to the multinomial logit, it benefits from not suffering from the Independence of Irrelevant Alternatives (IIA) assumption. For financial choice models, omitting that assumption is of realistic benefit[28]. A further advantage of using multinomial probit models to study the relationship between financial literacy and attitudes to cryptocurrencies lies with the ability to use all the information available, including answers

[26] The *Appendix Figure A4* presents the weighted frequencies of responses for our risk proxy question. Panel A presents the response figures in each of the five categories for the risk comparison with each of the six alternative assets. Panel B presents the percentage of individuals who find that cryptocurrency is much riskier or riskier than each of the alternative assets. Overall, 71.3% find that cryptocurrency is much riskier or riskier than cash, 64.9% find it is much riskier or riskier than bonds, 48% find it is much riskier or riskier than stocks, 67.3% find it is much riskier or riskier than real estate, 72% find it is much riskier or riskier than gold, and 59.7% find it is much riskier or riskier than investing in one's own business.

[27] In the *Appendix Table A3*, it is also shown that the individuals in high literacy group within each country give higher scores on all six risk perceptions of cryptocurrencies. These associations are also confirmed in the weighted pairwise correlation matrix in the *Appendix Table A4*.

[28] For instance, the assumption would signify that omitting the category for those who have not heard of cryptocurrencies before would induce the proportionate allocation of responses from the omitted category to the remaining categories, based on their observed frequencies.

from those respondents who identify with cryptocurrencies, because they have not heard them before.

[Insert Table 2 about here]

Our estimates confirm a negative relationship between financial literacy and ownership of cryptocurrencies. The relationship is economically and statistically significant at the 5% level. A 0.1 increase in the financial-literacy score from the average of 0.5177 decreases the predicted probability of cryptocurrency ownership by some 24.1%, i.e. by 2.08 percentage points − from 8.63% to 6.55%. An interquartile change in financial literacy, i.e. a change from 0.442 to 0.6233, decreases the probability of cryptocurrency ownership be some 38.1% or by some 4 percentage points, i.e. from 10.4% to 6.44%. The more financially literate are more likely to have heard of cryptocurrencies, but do not intend to own them in the future. A 0.1 increase in financial literacy increases the predicted probability of not intending to own by some 15.9%. Alternatively, an interquartile increase in financial literacy increases the predicted probability of not intending to own by some 32.7%. The more financially literate are less likely not to have heard of cryptocurrencies before. A 0.1 increase in financial literacy decreases the probability of ignorance regarding cryptocurrencies by some 13.9% and an interquartile increase in financial literacy decreases it by 22.7%.

The estimates of the remaining control variables show that technological literacy is significantly and positively associated with ownership and prospective ownership. It is significantly and negatively associated with the negative inclination regarding future ownership and with ignorance regarding cryptocurrencies. Our risk-tolerance proxy, i.e. inflectional FTR, is positively associated with the intension to own in the future and negatively associated with ignorance regarding cryptocurrencies. A higher preference for cash is positively associated with current ownership. It is negatively associated with negative inclination towards future ownership of cryptocurrencies. It is also positively associated with ignorance regarding cryptocurrencies. The first two patterns are likely to signify a positive association between informality and cryptocurrency ownership.

Males are less likely to be ignorant about cryptocurrencies, and they are both more likely to own/intend to own, but also to be negatively disposed about them. The effects are of larger magnitudes for ownership and prospective future ownership. There is a negative non-linear relationship between income and the negative inclination towards future cryptocurrency ownership. In contrast there is a positive convex relationship between income and ignorance about cryptocurrencies. In addition, younger groups are more likely to own and to intend to own cryptocurrencies, compared to their older counterparts.

The more highly educated are less likely to be ignorant about cryptocurrencies. They are more likely to own cryptocurrency at present. However, they are also more likely, not to intend to own. The self-employed are much more likely to own and intend to own cryptocurrencies compared to students and all remaining labour market groups. Employed individuals are more likely to own and less likely not to intend to own cryptocurrencies, compared to students. They are also more likely to have heard about them. The unemployed, the inactive, and retirees are less likely to intend to own cryptocurrencies in the future. They are also more likely to have heard about them, compared to students.

Table 2 documents that the more financially literate are significantly less likely to own and more likely not to intend to own cryptocurrencies, despite the fact that they are more likely to be aware of them. This confirms the pattern illustrated in Figure 5, which was displaying scatterplots of attitudes to cryptocurrencies vis-a-vis financial literacy scores at the country level. In that figure, countries with lower financial literacy score were exhibiting lower rates of ownership and prospective ownership of cryptocurrencies. In *Table 3*, we examine country variations in the relationship between financial literacy and our four response categories for attitudes to cryptocurrencies. We introduce a set of 15 interaction terms between counties and financial literacy.

[Insert Table 3 about here]

The estimates confirm the robustness of our findings in Table 2, as the effect of financial literacy on cryptocurrency ownership remains negative and statistically significant at the 5% level. Moreover, it remains positive and statistically significant at the 1% level, with respect to the negative inclination to own in the future. It also remains

negative and statistically significant at the 1% level when it comes to the probability of having heard of cryptocurrencies before. However, the country interactions also indicate country heterogeneity in the effect of financial literacy on cryptocurrency ownership. There are positive effects on ownership from the interaction terms between financial literacy and residents of Austria, Germany, Luxembourg, the Netherlands, the Czech Republic, and Australia. The reference category in this comparative assessment is the interaction term with Belgium, i.e. the country with the lowest ownership rates.

4.2 Robustness exercises

In this sub-section, we conduct a number of robustness exercises to confirm the validity of our primary findings, i.e. the negative relationship between financial literacy and cryptocurrency ownership, the positive relationship between financial literacy and the intension not to own cryptocurrencies in the future, and the negative relationship with unawareness about cryptocurrencies.

Our first robustness exercise in *Panel A* of *Table 4* involves the multinomial probit estimation with bootstrapped standard errors, based on 1,000 replications. The exercise stems from the fact that our financial literacy proxy is derived from an external database, i.e. the S&P 2014 Global Financial Literacy Survey and is matched to the ING Mobile Banking Survey based on gender, age and income categories. Any resulting 'match bias' could affect the standard errors of the multinomial probit regressions. The estimates with bootstrapped standard errors in Panel A confirm the robustness of our findings. There is a negative effect of financial literacy on cryptocurrency ownership, significant at the 10% level. There is a positive effect of financial literacy on the negative predisposition to own cryptocurrency in the future, significant at the 5% level. Moreover, there is a negative effect of financial literacy on ignorance about cryptocurrencies, significant at the 1% level.

[Insert Table 4 about here]

In *Panel B* of Table 4, we present bootstrapped marginal effects and standard errors from multinomial probit regressions, based on 1,000 replications. The rationale of the exercise is to confirm that our previous estimates are not due to any 'match bias' or inconsistent weighting. The bootstrapped estimates confirm our previous findings, and the

effects are very similar, both in terms of significance and magnitude. ***Panel C*** replicates our primary estimation of Table 2, removing the individual weights used to make the sample estimates representative at the country level. Once more, the unweighted estimates confirm the robustness of our findings, both in terms of significance and magnitude.

In ***Panel D*** of Table 4, we conduct an additional exercise, aiming to cater to any concerns regarding the large differences in financial literacy that exist between countries. We employ a binary 'High financial literacy' (*hereafter* FLH) indicator, which stems from the computation of percentiles of financial literacy for each country separately. Individuals are in the FLH group if their financial-literacy percentile within their country is greater than 50. If their proxy score belongs to a within-country percentile that is less than 50, they are in the low financial literacy group (hereafter FLL). Hence, any concerns regarding the results being driven by the higher financial literacy scores in particular countries should be mitigated via this exercise. Indeed, the estimates of Panel D confirm that the 'high financial literacy' group within each country is 16% less likely to own cryptocurrencies, i.e. 1.4 percentage points less likely with the predicted probability of ownership being 8.74%. The effect is significant at the 5% level. Moreover, individuals in the 'high financial literacy' group in each country are 9.9% more likely not to intend to own cryptocurrencies in the future, and they are 9% less likely not to have heard about them.

In ***Panel E*** of Table 4, we utilise a logarithmic financial literacy measure. The estimates confirm the robustness of the negative effect of financial literacy on cryptocurrency ownership, and the effect becomes significant at the 1% level. Moreover, the positive effect of financial literacy on the negative disposition to own cryptocurrencies in the future remains and is significant at the 1% level. The magnitudes of both effects are similar to our baseline estimates in Table 2. Finally, the negative effect of financial literacy on unawareness about cryptocurrencies remains but becomes marginally insignificant at the 10% level.

In ***Panels F and G***, we experiment with two alternative financial literacy measures. Our alternative measure I is computed as $\mathrm{FL}_{\mathrm{i}}^{1} = \prod \frac{\mathrm{FL}_{\mathrm{gender}}\mathrm{FL}_{\mathrm{age}}\mathrm{FL}_{\mathrm{income}}}{\mathrm{FL}_{\mathrm{country}}^{2}}$, i.e. as a multiplication of the three financial literacy scores by gender, age and income in each

country, and divided with the squared country-level financial literacy score. Then, our alternative measure II removes any country level differences in financial literacy by dividing the multiplicative product of the three scores by the cubed country-level score, i.e. $\mathrm{FL}_{\mathrm{i}}^{2} = \prod \frac{\mathrm{FL}_{\mathrm{gender}}\mathrm{FL}_{\mathrm{age}}\mathrm{FL}_{\mathrm{income}}}{\mathrm{FL}_{\mathrm{country}}^{3}}$. Hence, once more, country-level differences are omitted, and our alternative measure II becomes a ranking of the probability for each individual in each country to know at least 3 out of 4 financial-literacy concepts. The effect of an interquartile increase (from 0.4289 to 0.6514) in FL^1 on the probability of cryptocurrency ownership is -15.5% and significant at the 5% level. It is 12.6% on the intension not to own cryptocurrencies in the future, and significant at the 1% level. In addition, the effect is in the magnitude of -10.4% on the probability of being unaware of cryptocurrencies. Then, the effect of an interquartile increase (from 0.9087 to 1.1824) in FL^2 on the probability of cryptocurrency ownership is -12.5% and significant at the 1% level. It is 6.8% on the intension not to own cryptocurrencies in the future, and significant at the 1% level. In addition, the effect is in the magnitude of -3.8% on the probability of being unaware of cryptocurrencies, and significant at the 10% level.

Finally, *Panels H and I* present weighted multinomial probit estimates for the sub-samples of males and females. The results are robust for the male sub-sample and mostly robust for the female sub-sample. The effect of a 0.1 increase in financial literacy on the probability of cryptocurrency ownership is in the magnitude of -29.6% for males and that of an interquartile change in financial literacy is in the magnitude of -44.9%. The effect is of similar magnitude for females, but the marginal effect becomes insignificant at conventional levels for the female sub-sample. This is likely to stem from the fact that both financial literacy and cryptocurrency ownership are lower amongst the female sub-sample. The remaining effects are robust and of higher magnitudes for the male sub-sample, compared to the female sub-sample. Higher financial literacy is positively related to not intending to own cryptocurrencies in the future. The effect is in the magnitude of 22% for males and 15.2% for females. Finally, it is confirmed that higher financial literacy is negatively related to unawareness about cryptocurrencies. The effect is in the magnitude of -17.3% for males and -11.2% for females.

Another major concern regarding the robustness of our primary findings could stem from the structure of the categorical responses in our variable for attitudes to cryptocurrencies. These also include the individuals who have never heard of cryptocurrencies before, as the fourth response category. In ***Table 5***, we implement a two-stage methodology, presenting marginal effects from a multinomial probit model with three categories and a 1st stage selection equation[29]. The estimates are weighted, and robust standard errors are shown in brackets. At the first stage, we estimate the probability to have heard about cryptocurrencies, and then, at our 2nd stage, we distinguish between owning, expecting to own in the future, and not expecting to own in the future. As an exclusion restriction in our 1st stage selection equation, we include an additional variable capturing ignorance regarding online payment methods. The wording of the original question was: "*Would you be willing to use any of these providers to pay for goods and services 6 months from now, either in store or online? Please select all the payment methods you would use*" Multiple responses were allowed. The exclusion restriction captures the lack of awareness of the following main providers, as options to pay for goods and services in the near future, either in store or online: ApplePay, Google/AndroidPay, PayPal, Facebook, AmazonPay (Amazon account), own bank's app. It is a continuous index, ranging from 0 to 1 and stemming from the division of the summation of the 6 dummy variables on unawareness regarding each of the 6 providers, divided by 6. The summary statistics in Table 1 indicate that individuals who have not heard of cryptocurrencies have the highest score on unawareness of online payment methods too, and the difference is large with the other categories.

[Insert Table 5 about here]

In Table 5, we present our estimates from the multinomial probit model with selection. The estimates confirm the robustness of the findings in our baseline model, which did not account for selection. Greater familiarity with online payment methods is positively related to having heard of cryptocurrencies. So is financial literacy in our selection equation, but the effect is of a smaller magnitude, compared to our model in Table

[29] The multinomial probit model with a selection equation is estimated using the cmp routine in Stata. The Geweke-Hajivassiliou-Keane algorithm is used for simulating the cumulative multivariate normal distribution (Cappellari and Jenkins 2003; 2005; Gates 2006).

2. Moreover, it is significant at the 10% level. At the 2nd stage estimates, an increase in financial literacy by 0.1 reduces the probability of cryptocurrency ownership by -15.6%. The effect is significant at the 1% level. An interquartile increase in financial literacy reduces the probability of ownership by -25.5%. Financial literacy is negatively related to the probability of intending to own cryptocurrencies in the future and the effect is only marginally insignificant at the 10% level. It is positively related to not intending to own, and a 0.1 increase in financial literacy increases the probability of not intending to own by 5.4%. An interquartile change in financial literacy increases it by 10.2%. Hence, the estimates from a multinomial probit model with selection confirm and further reinforce the robustness of our baseline findings from Table 2[30].

4.3 Mechanisms I-IV: Technological literacy, informality, young age, and financial advice

So far, we have established that financial literacy is positively related to awareness of cryptocurrencies, negatively related to current ownership of any cryptocurrencies, and positively related with a negative inclination towards future ownership. In this section, we try to identify the mechanics of these relationships, by presenting multinomial probit models, using the same baseline specification as in our Table 2, and adding interaction terms between financial literacy and some of the key candidate explanations of the relationships we have identified.

In columns A_1-A_4 of ***Table 6***, we present estimates in which we interact financial literacy with the technological literacy variable. The effects of the interaction terms between financial literacy and technological literacy are small and insignificant at any

[30] For completeness, we also present an additional robustness check in our Appendix Table A5. In the multinomial probit specification of Table 2, we replace the 5 education categories with a continuous variable capturing years of education. The continuous years of education variable is computed as follows: Individuals with 'Pre-sixteen education' get assigned with 9 years of education. Individuals with 'A-levels, GNVQ or college' get assigned with 12 years of education. Respondents with 'Higher vocational education or HND' get assigned with 14 years. Then, respondents with 'University (Bachelor)' get assigned with 16 years, and individuals with 'Higher university degree' get assigned with 19 years. Then, we estimate, including a triple interaction term between financial literacy, years of education, and the logarithm of monthly PPP-divided household income per capita. We omit the 3rd order polynomial in income in this specification. The estimates of the Appendix Table A5 confirm the robustness of our findings. This is also the case in models with separate interaction terms between financial literacy and the years of education, and financial literacy and income. These results are also available upon request. Hence, our findings are not driven primarily by education or income.

conventional levels. Moreover, the sign, the magnitude and the significance of the marginal effects of financial literacy on our 4 categories for attitudes to cryptocurrencies remain largely unaffected, and similar to those estimated in Table 2.

[Insert Table 6 about here]

In columns B_1-B_4 of Table 6, we present estimates in which we interact financial literacy with our preference for cash variable. The results confirm that that a higher preference for cash, and potentially informal conduct, does not explain the negative relationship between financial literacy and cryptocurrency ownership. There is a positive effect of the interaction term between financial literacy and the preference for cash on the intension to own in the future. Moreover, there is a negative effect of the interaction term on not intending to own in the future. There is also a marginally insignificant effect of the interaction term on the probability of current ownership. These might suggest that our preference for cash variable could be depicting favourable attitudes towards informal practices, and those favouring such practices might be both more financially literate and in favour of cryptocurrency ownership. However, both the magnitude and the significance of all our previous findings remains. Hence, neither higher financial literacy among the more technologically literate nor lower financial literacy among those favouring informal practices[31] explain why financial literacy is negatively related to cryptocurrency ownership and positively related to the intension not to own cryptocurrency in the future.

In *Table 7*, we present marginal effects from multinomial probit estimates, in which we interact financial literacy with age categories. In the specification of columns A_1-A_4, we adhere an interaction term between financial literacy and a dummy variable for younger age, taking the value one for individuals younger than 45. Alternatively, the effect could be driven by a non-linear relationship between financial literacy and age, and by the older being less willing to engage with cryptocurrencies. The correlation matrix of the *Appendix Table A2* confirms a positive weighted pairwise correlation between financial literacy and the continuous age variable. Hence, in the specification of columns B_1-B_4, we adhere six

[31] The higher technological literacy and the lower preference for cash by the more financial literate is indicated in the *Appendix Table A3*. So is the higher financial literacy among the younger sub-sample (<45).

interaction terms between financial literacy and dummy variables for each of our six age groups, namely individuals aged 18-25, 26-35, 36-45, 46-55, 56-65 (reference category), and 66-75. Both sets of estimates confirm the robustness of our findings. The more financially-literate young individuals are more likely to own and intend to own cryptocurrencies, and less likely not to intend to own and not to have heard about cryptocurrencies. However, financial literacy remains negatively related to current ownership and the effect is significant at the 10% level. It remains positively related to no intension to own in the future and negatively related to unawareness about cryptocurrencies. Hence, the higher cryptocurrency ownership and positive disposition towards cryptocurrencies among the more financially literate younger sub-sample is not the primary driver of the effect of financial literacy.

[Insert Table 7 about here]

In *Table 8*, we test one additional explanation for the established relationship between financial literacy and attitudes to cryptocurrencies, for the sub-sample of the 9,538 individuals who have heard of cryptocurrencies before. In the estimates of columns A_1-A_3, we depart from the baseline specification and adhere five dummy variables for financial advice. Then, in columns B_1-B_3, we also adhere the respective interaction terms between financial literacy and different sources of financial advice on investment and cryptocurrencies[32].

[Insert Table 8 about here]

The estimates in columns A_1-A_3 of Table 8 indicate that more sophisticated types of financial advice on cryptocurrencies exert a higher impact on the probability of ownership. Hence, individuals seeking for tailored advice on computer programs and algorithms, as well as advice from the internet and specialist websites are more likely to own cryptocurrencies, compared to those not seeking any advice on cryptocurrencies. This is also the case for individuals seeking for related advice from friends and family, and from

[32] We merge the two final categories in one variable − namely (5) I (would) never invest money in cryptocurrency and (6) I don't know − into one category depicting not seeking specific financial advice regarding cryptocurrencies. It is worth noting that our estimates remain unaffected by the merging and that, when used separately, the two variables (and their interaction terms with financial literacy) have almost identical effects on attitudes to cryptocurrencies. These results are available upon request.

an independent financial or bank advisor. The effect on cryptocurrency ownership from advice from an independent financial or bank advisor is of a smaller magnitude, compared the effects of the remaining sources of advice. The effects of financial literacy on attitudes to cryptocurrencies remain unaffected by the inclusion of the related financial advice variables in columns A_1-A_3., in all terms of sign, significance and magnitude. The effects of financial literacy become even larger in size, and the negative effect of financial literacy on current ownership becomes significant at the 1% level.

In columns B_1-B_3, we also adhere interaction terms between financial literacy and the sources of financial advice on cryptocurrencies. Some interesting patterns prevail with respect to the effects of the interaction terms. Financially literate individuals seeking for advice from the internet and specialist websites are less likely to own cryptocurrencies. Moreover, financially literate individuals seeking for financial advice from friends and family are more likely to intend to own and less likely not to intend to own in the future. This could be indicative of a either selection of distinctive information sources by the more financially literate or of peer effects stemming from imitation of friends and family. However, once more, the effects of the financial literacy variable remain robust and of similar magnitudes to those of Table 2.

4.4 Mechanism V: Perceptions of reward and risk

In the previous sub-section, we established that none of the current proposed mechanisms so far − namely technological literacy, preference for cash/informality, young age, and financial advice − can explain the established relationships between financial literacy and attitudes to cryptocurrencies. In this sub-section, we aim to test a fifth mechanism, which is compatible with what our expectation regarding what the role of financial literacy would be on financial decision making. One would expect the financially literate to be in a better position to evaluate financial risk, and the related relationship between risk and reward. In order to examine this prediction, we interact financial literacy with proxies for the likely reward and risk from engagement with the cryptocurrency market.

In *Table 9*, we introduce a set of three cardinal variables capturing the reward prospects of holding cryptocurrencies. We estimate our multinomial probit specification for individuals who have heard of cryptocurrencies before and introduce the three variables, ranging from 1 to 5 (columns A_1-A_3). For each of the three variables, higher values indicate that respondents are more likely to agree that cryptocurrencies are the future of spending online, the future of investment as storage of value, and that the value of cryptocurrencies will increase in the next 12 months, respectively. In columns B_1-B_3, we also introduce interaction terms between financial literacy and each of the three reward perception variables. The estimates in columns A_1-A_3 indicate that all three reward perceptions regarding the prospects of cryptocurrencies are positively related to ownership and prospective future ownership. They are also negatively related to not intending to own cryptocurrencies in the future. The inspection of the coefficients suggests that the investment motive has a smaller marginal effect on current ownership, compared to the consumption or speculation motive. Moreover, the speculation motive has a smaller marginal effect on the positive disposition to future ownership, compared to the consumption and investment motive. Finally, the consumption motive exerts a higher impact than the investment motive, and the investment exerts a higher impact than the speculation motive, on the negative disposition to future ownership.

[Insert Table 9 about here]

The estimates in columns B_1-B_3 indicate that the interaction terms between financial literacy and the three reward perceptions on cryptocurrencies exert insignificant impacts on all three attitudes to cryptocurrencies. The effect of financial literacy remains significant and has a similar magnitude to our baseline model in Table 2, when we introduce the reward proxies on cryptocurrencies and their interaction terms with financial literacy in columns B_1-B_3. The large negative effect of financial literacy on current ownership is significant at the 10% level and the strong positive effect on the disposition not to own in the future is significant at the 5% level. Hence, different perceptions regarding the prospective rewards of investment in cryptocurrencies by the financially literate are not the main mediating factor for the effects we find for financial literacy on attitudes to cryptocurrencies.

In *Table 10*, we introduce a set of six cardinal variables capturing the perceptions of the risk involved in investment in cryptocurrencies, compared to six alternative assets, namely cash, bonds, stocks, real estate/property funds, gold, and investment in one's own business. We estimate our multinomial probit specification for individuals who have heard of cryptocurrencies before and introduce the six variables, which range between 1 and 5 (columns A_1-A_3). For each of the six variables, higher values indicate that respondents find that holding cryptocurrencies entails more risk compared to holding each of the six alternative assets, respectively. In columns B_1-B_3, we also introduce interaction terms between financial literacy and each of the six risk perception variables. The estimates in columns A_1-A_3 indicate that respondents who find that cryptocurrencies are riskier than cash, bonds, stocks, and investment in own business are less likely to own cryptocurrencies. These risk variables also exert a negative effect on the intension to own in the future and a positive effect on the intension not to own in the future. Moreover, those who find that cryptocurrencies are riskier than gold are more likely to intend to own cryptocurrencies in the future.

[Insert Table 10 about here]

The estimates in columns B_1-B_3, in which interaction terms between financial literacy and the six risk perceptions are introduced in the specification, show some interesting patterns. Firstly, there are significant negative interaction effects on the probability to own cryptocurrency. These are the effects of the interaction terms between financial literacy and the perception that cryptocurrencies are riskier than real estate/property funds, and financial literacy and the perception that they are riskier than gold. There is a positive effect on the probability to own cryptocurrencies by the interaction term between financial literacy and the perception that cryptocurrencies are riskier than investment in own business. Hence, the financially literate individuals who find cryptocurrencies riskier than real estate and gold are less likely to own cryptocurrencies at present. This is likely to indicate a greater ability by the more financially literate to assess the true risk of cryptocurrencies, in comparison to these alternative assets which entail the highest risk among the options offered. Financially literate respondents, who find cryptocurrencies entail more risk than entrepreneurship, are more likely to own cryptocurrencies. This is a rather odd finding, which could be driven by the highest cryptocurrency ownership among the self-employed

or by the fact that entrepreneurship entails an innate ability and is not really seen as an alternative asset by the non-entrepreneurial population. Secondly, in the specification with the interaction terms of columns B_1-B_3, the effect of financial literacy on attitudes to cryptocurrencies lowers in magnitudes and becomes insignificant in all three columns. Hence, it appears that the negative effect of financial literacy on cryptocurrency ownership and the positive effect on the intension not to own cryptocurrency in the future is primarily driven by the different assessment of the risk of cryptocurrencies, compared to alternative assets, by the more financially literate. This is in accordance with our prior expectation that the ability to assess financial risk is a key financial literacy skill.

In *Table 11*, we introduce both sets of reward and risk perceptions regarding cryptocurrencies (columns A_1-A_3), and then, the interaction terms between financial literacy and the 3 reward variables and the 6 risk variables (columns B_1-B_3). The estimation results in columns A_1-A_3 are identical to those of the respective columns of Table 9 and 10. The effects of financial literacy on attitudes to cryptocurrencies remains significant and similar to those of our baseline specification in Table 2. In the models with the nine interaction terms in columns B_1-B_3, the effect of financial literacy diminishes both in terms of magnitude and significance. This confirms and further reinforces the findings of the previous Table 10. After all, the ability to understand financial risk should entail a correlation with understanding financial reward prospects, as well as an understanding of the relationship between financial risk and reward.

[Insert Table 11 about here]

In *Table 12*, we introduce a set of variables for perceptions of reward and risk, which are continuous transformations of the respective sets of variables used in the previous tables. Specifically, in columns A_1-A_3, we introduce a reward perception variable, which stems from the summation of the 3 reward variables, divided by 15, i.e. $Reward^{Alter} = \sum_{i-1}^{3} \frac{Reward_i}{15}$. The risk perception variable is the summation of the 6 risk variables, divided by 30, i.e. $Risk^{Alter} = \sum_{i-1}^{6} \frac{Risk_i}{30}$. Then, in columns B_1-B_3, we also introduce two interaction terms, one between financial literacy and the continuous reward variable, and another between financial literacy and the continuous risk variable. The results in columns

A_1-A_3 confirm that the reward perception exerts a large positive impact on cryptocurrency ownership and prospective ownership in the future. It exerts a large negative impact on the intension not to own cryptocurrency in the future. The risk perception variable exerts a smaller negative impact on the probability of cryptocurrency ownership. The effects of financial literacy remain significant and in magnitudes similar to those of our baseline specification in Table 2.

[Insert Table 12 about here]

The estimates in columns B_1-B_3 produce a negative interaction term between financial literacy and the cryptocurrency risk perception on the probability to own cryptocurrencies. The effect of the interaction term is large in magnitude and the effect of financial literacy diminishes both in size and significance. Hence, it is confirmed that the negative effect of financial literacy on cryptocurrency ownership is driven by a different perception of risk regarding cryptocurrencies by the more financially literate, compared to the less financially literate individuals[33]. The estimates in columns B_1-B_3 also produce a positive effect of the interaction term between financial literacy and the reward perception on the intension to own cryptocurrencies in the future. This can be interpreted as a moderate reward-driven intension to own by the more financially-literate, which however did not materialize into cryptocurrency ownership at present. All main financial literacy effects on attitudes to cryptocurrencies diminish, both in terms of magnitude and significance, in the specification with the interaction terms between financial literacy, reward and risk.

4.6 Validation: Financial-literacy constituents and interaction with risk tolerance

The inquiry into the mechanics of the relationships between financial literacy and attitudes to cryptocurrencies suggests that the candidate explanation is the enhanced ability by the more financially literate to evaluate the risk prospects of owning cryptocurrencies, compared to the risks of engaging in alternative assets and other types of investment

[33] The weighted pairwise correlation matrix in the Appendix Table A4 has already indicated a positive correlation between financial literacy and the perception about the risk of cryptocurrencies, and a bigger negative correlation with the perception about the reward from cryptocurrencies. This is also confirmed in the mean differences between the FLH and the FLL groups in the Appendix Table A3.

activity. In this section, we conduct two sets of exercises, aiming to validate this conjecture from the previous sub-section.

In *Table 13*, we estimate a multinomial probit regression for the full sample, introducing four new variables, which correspond to the four distinctive country-level financial-literacy constituent concepts, namely the country score on understanding financial risk, the score on understanding inflation, the score on understanding simple interest (numeracy), and the score on understanding interest compounding. In this specification, we omit the country fixed effects, to avoid multicollinearity with our four country-level scores. The financial-literacy constituent variables are computed as $FL_{constituent}^{individual} = \prod \frac{FL_{constituent}^{country} \mathrm{FL}_{\mathrm{gender}} \mathrm{FL}_{\mathrm{age}} \mathrm{FL}_{\mathrm{income}}}{\mathrm{FL}_{\mathrm{country}}^{4}}$, where, by $FL_{constituent}^{country}$, we mean the country scores in each of the four distinctive financial-literacy concepts in the S&P 2014 Global Financial Literacy Survey. This exercise renders four variables that vary at the individual level in the merged dataset and omit country level differences in overall financial literacy.

[Insert Table 13 about here]

The estimates in Table 13 show that understanding financial risk is negatively associated with cryptocurrency ownership. It is also negatively associated with the intension to own in the future and positively associated with the intension not to own in the future. Among the basic four financial-literacy components, understanding financial risk is the one variable that exerts a significant negative impact on any favourable attitudes to cryptocurrencies. In contract, understanding interest compounding seems to be positively associated with cryptocurrency ownership and exerts negative effects on both the positive and the negative inclination towards future ownership. Overall, the results of this exercise are in accordance with the interpretation that understanding financial risk, i.e. a key financial literacy skill, is negatively related to cryptocurrency ownership and the inclination in favour of future ownership.

In *Table 14*, we conduct one final exercise aiming to test the validity of our proposed mechanism in a broader context. If the financially literate are negatively disposed towards cryptocurrencies, due to being in a better position to evaluate the financial risk entailed in

their ownership compared to other investment alternatives, does this mean that the more financially-literate risk tolerant individuals will be in a better position to avoid any innate inclination towards high-risk investment, such as that in cryptocurrencies? To evaluate this question, we utilise a risk tolerance proxy enabled by the inflectional FTR variable and present multinomial probit estimates, in which we introduce an interaction term between financial literacy and the inflectional FTR. The results are shown in Table 14 and they show that inflectional FTR exerts a large positive impact on cryptocurrency ownership. The interaction term between financial literacy and inflectional FTR exerts an even larger negative impact on the probability to own cryptocurrencies. Moreover, the effect of financial literacy on cryptocurrency ownership in column A_1 diminishes in magnitude and significance. In similar spirit, although the more risk tolerant are less likely not to intend to own cryptocurrencies in the future, the financially-literate risk tolerant are more likely not to intend to own. Evidently, greater financial literacy skills among individuals who would be keener to undertake greater financial risk might help prevent some of the natural urges to rush into careless investment decisions.

[Insert Table 14 about here]

5. Concluding remarks

This study examines the significant role of financial literacy in the formation of attitudes regarding cryptocurrency ownership globally. We show that financial literacy exerts a statitically significant negative impact on the probability to own cryptocurrency. Financially literate individuals are also more likely not to intend to own cryptocurrency in the future. Overall, the are more likely to have heard about cryptocurrencies and be aware of them. Our analysis also shows that the size of these effects is economically important and robust in different specifications, when using different financial literacy definitions, and when including a rich set of control variables. We also show our results are robust when using a sample selection model, with awareness about cryptocurrencies at the first stage. Examining the mechanics of the established relationships, we find that the effect of financial literacy remains unaltered in models with interaction terms between financial

literacy and technological literacy, preference for cash/informality, age, and financial advice, inter alia.

The one mechanism that mediates the relationship between financial literacy and attitudes to cryptocurrencies is the perception of the risk that cryptocurrencies entail, in comparison to alternative assets. In models with interaction terms between financial literacy and the risk perception, significant interaction effects are found, and the effect of the financial literacy variable diminishes in size and significance. This conjecture is confirmed by the greater negative impact of the financial-risk constituent of the financial literacy measure on ownership and on the intension to own cryptocurrencies in the future. It is also confirmed by a large negative effect on ownership by the interaction term between financial literacy and generic risk tolerance, as approximated by the inflectional FTR of the individual's language. We interpret our results as indicative that greater financial literacy skills among individuals who would be keener to undertake higher financial risk might help prevent some of the innate urges to rush into very high-risk investment decisions.

The importance of financial literacy in modern economies cannot be overemphasized. Financial literacy has a clear public good element to it, as it has been conceptually linked to macroeconomic financial stability. Lusardi et al. (2017) assess that differences in financial knowledge formed early in life can explain some 35-40% of retirement wealth inequality in the United States. We find our findings are complementary to this recent insight, by suggesting that financial literacy is negatively associated with investment decisions towards highly volatile assets such as cryptocurrencies. More recently, Foley et al. (2019) present evidence suggesting that some 46% of bitcoin transactions are related to illegal activity, and some $10 billion in assets are managed by dedicated 'cryptofunds'. Such activity is less likely to be captured in surveys. Our survey inquiry comes at a timely and complementary fashion to that recent evidence. It is conducive to shedding light to the demand side of cryptocurrencies and suggests that apart from illegal and exclusive activity, a large part of the cryptocurrency market comprises of unsophisticated investors with lower financial literacy skills. These investors are likely to overestimate the reward prospects in cryptocurrencies and underestimate the risk involved in related investment. For any new financial instrument or alternative asset to become established, less volatile and subject to manipulation, the market needs to be dominated by

sophisticated investors and legitimate transactions. Our evidence and the recent evidence regarding the uses of the bitcoin suggests that the current state of the market for cryptocurrencies is far from that. Hence, the concerns by regulators are completely justified and efforts are needed to increase the public understanding of the supply side and enable an inquiry into the motivation and incentives of the demand side in the market for cryptocurrencies. This will increase awareness, transparency, and might ultimately make this market less volatile, more predictable and less subject to any manipulation.

We contribute to the financial economics literature by presenting novel evidence suggesting that the financially literate are less likely to invest in the cryptocurrency market, due to a more informed perception regarding the risks involved, compared to alternative assets. With most economic models relying on the premise of rational agents, any cognitive skills that are likely to induce such behaviour, such as financial literacy in our setting, are likely to be conducive to the validity and predictive power of these economic models. Such models and predictions are essential for the highly volatile and largely unpredictable cryptocurrency market. We contribute to the literature on educational finance and education economics. Our findings may potentially be considered when designing policy interventions related to FinTech and related investor participation, by including elements on digital finance with the objective to provide a broader view on the subject. Finally, from a socioeconomics perspective, efforts to improve financial literacy can be conducive to the process of transparency in the introduction of new financial instruments.

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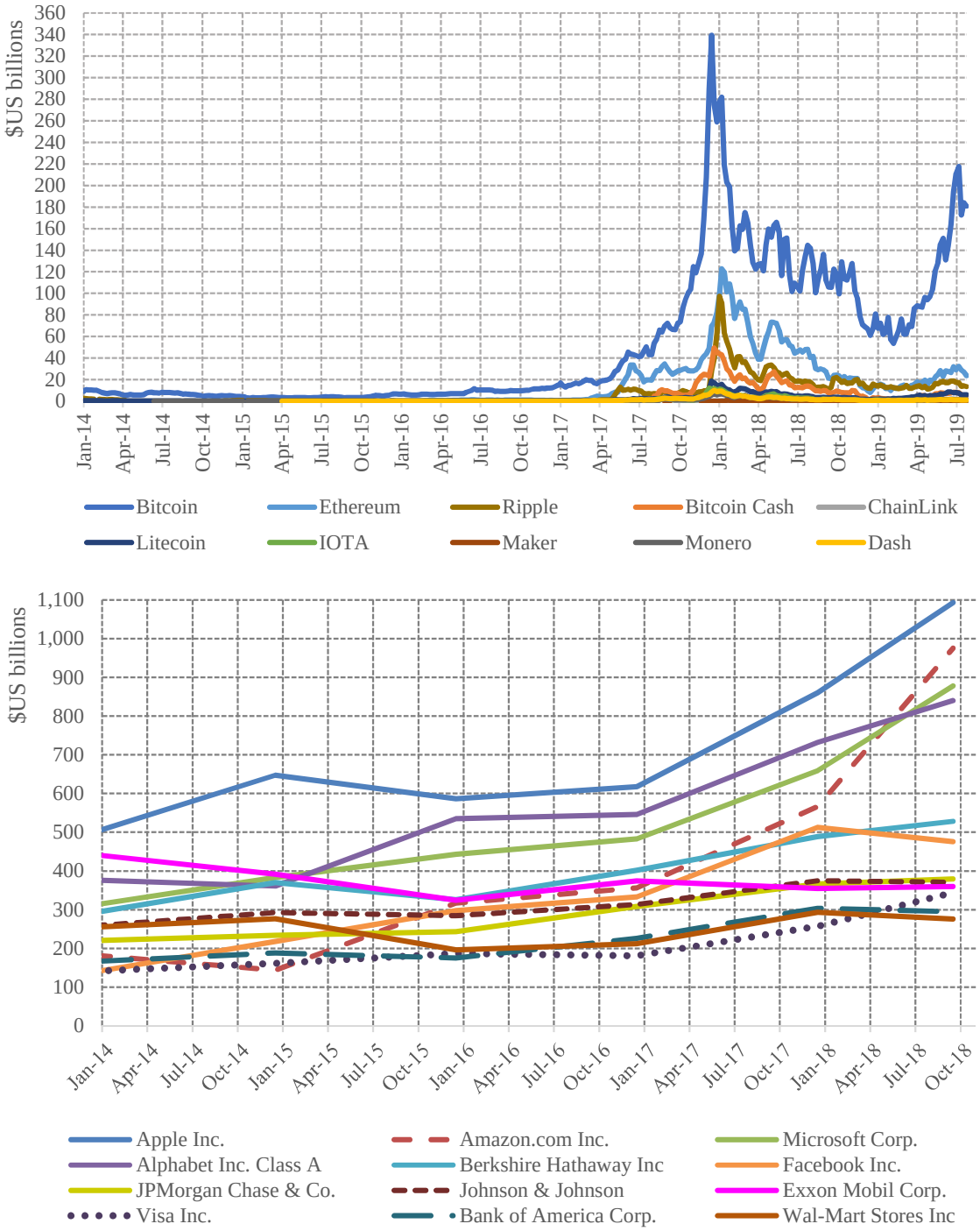


Figure 1
Market capitalisation among cryptocurrencies and the largest S&P companies

This figure presents the ten cryptocurrencies with the highest market capitalization for the period 2014-2019, namely the Bitcoin, Ethereum, Ripple, Bitcoin Cash, ChainLink, Litecoin, IOTA, Maker, Monero, and Dash. The data on market capitalization among cryptocurrencies stems from: https://www.cryptocurrencychart.com/top/25, and that on the largest 12 S&P100 companies from: http://siblisresearch.com/data/market-caps-sp-100-us/

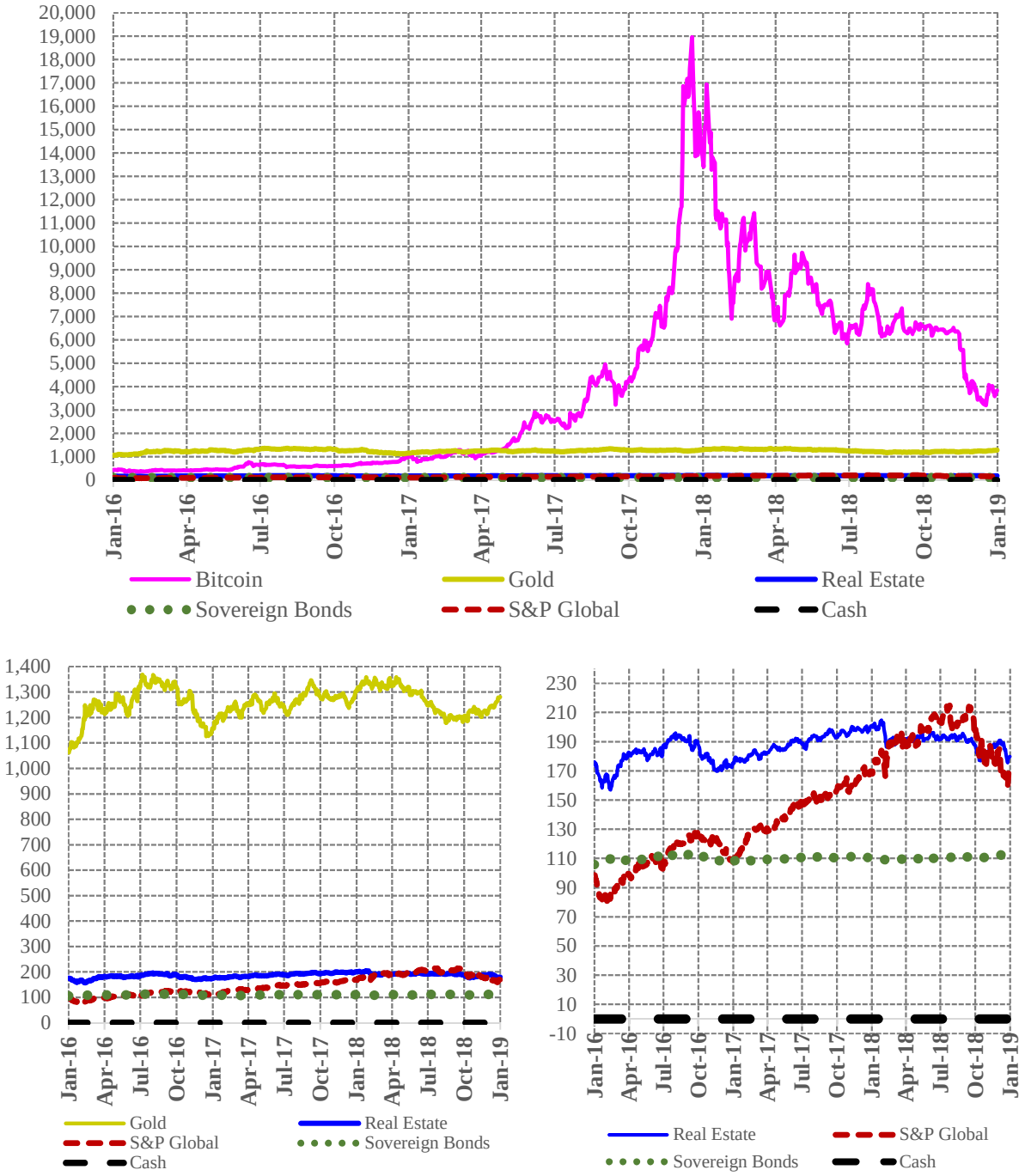


Figure 2
The price development of the Bitcoin and other asset classes between 2016-2019 ($US)

This figure presents the price development of the bitcoin for the period between 2016-2019, compared to other asset classes, namely gold, real estate, sovereign bonds, equities, and cash. The data stems from Thomson Reuters and Bloomberg for the period 1.1.2016 – 1.1.2019. The price of the US T-Bill is used as a cash proxy. The Bloomberg Barclays GDP Core Developed Govt AA- or Above TR Hedged USD is used for sovereign bonds. The MSCI ACWI REAL ESTATE USD price index is used for real estate. The SP GLOBAL total return index is used for Equities. The Gold Bullion LBM $/t, US T-Bill is used for Gold. The Bitcoin daily price in USD stems from Coindesk.

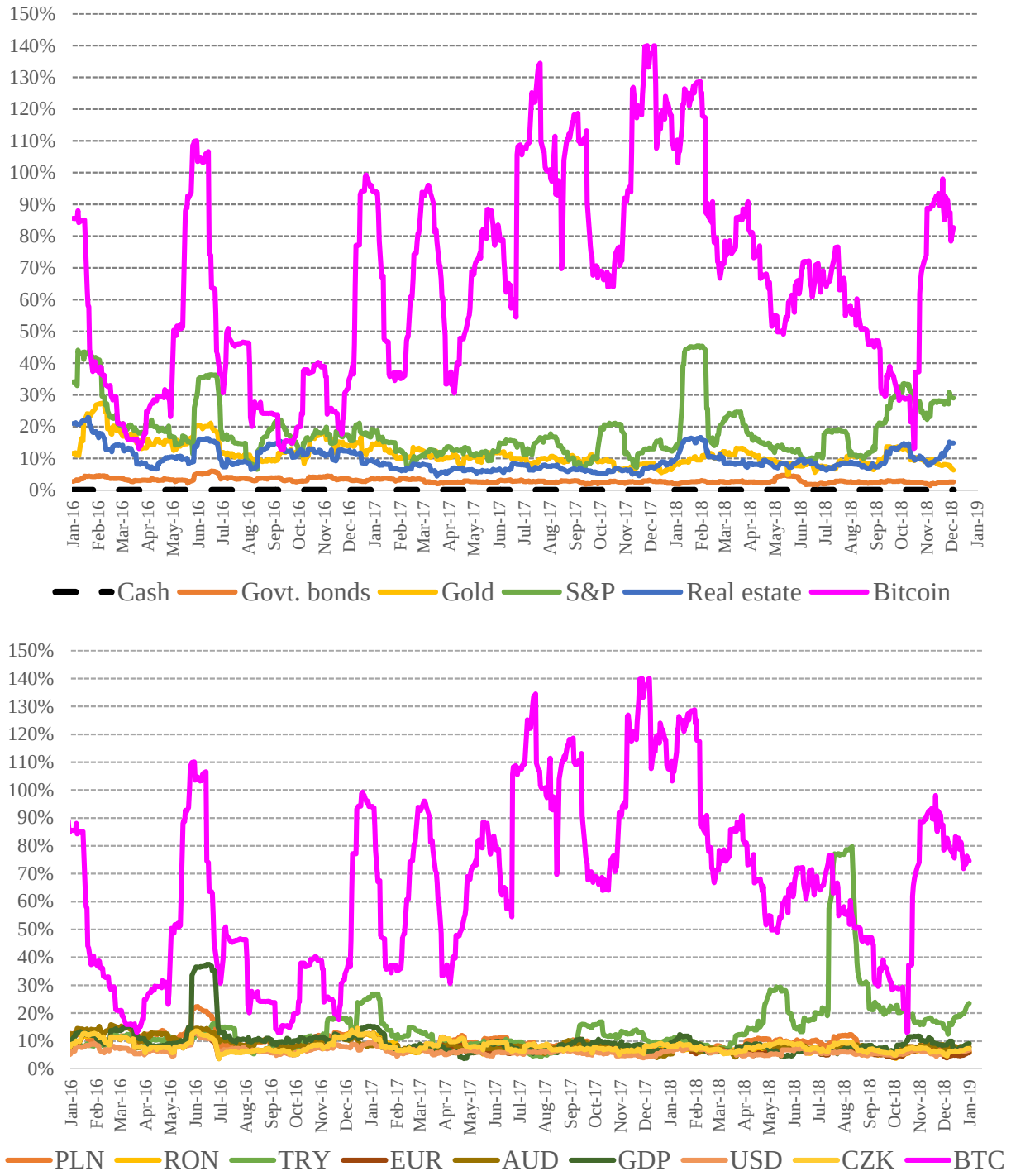


Figure 3
Daily one-month running annualised volatilities of the bitcoin and international currencies

The top panel of this figure presents daily one-month running annualized volatilities for the bitcoin and selected asset classes, namely gold, real estate, sovereign bonds, equities, and cash. The data stems from Thomson Reuters and Bloomberg for the period 1.1.2016 – 1.1.2019, and the proxies used are identical to those in Figure 2. The bottom part of the figure presents daily one-month running annualized volatilities for the bitcoin and currencies of the counties in the ING International Survey on Mobile Banking for the same period, namely the Polish Zloty, the Romanian Leu, the Turkish Lira, the Euro, the Australian dollar, the British pound, the US dollar, and the Czech Koruna.

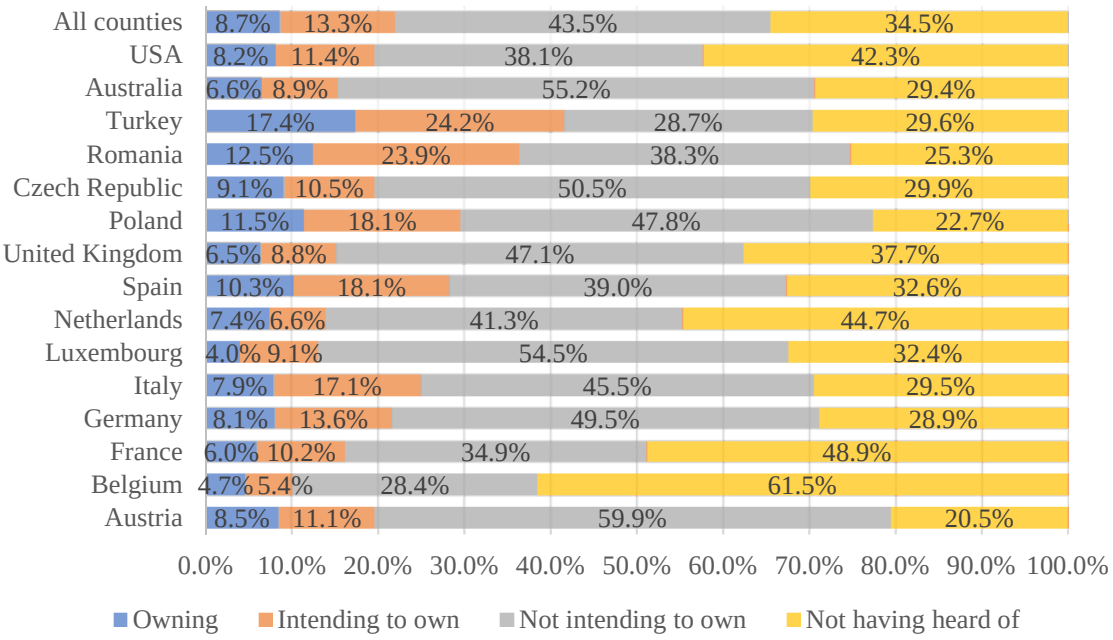


Figure 4
Attitudes to Cryptocurrencies (ING International Survey on Mobile Banking, 2018)

This figure presents the frequencies of responses to our main question regarding attitudes to cryptocurrencies, overall and by country. Weighted frequencies are shown for the four categories of responses, i.e. owning cryptocurrencies, not owning but intending to own, not owning and not intending to own, and not having heard of cryptocurrencies.

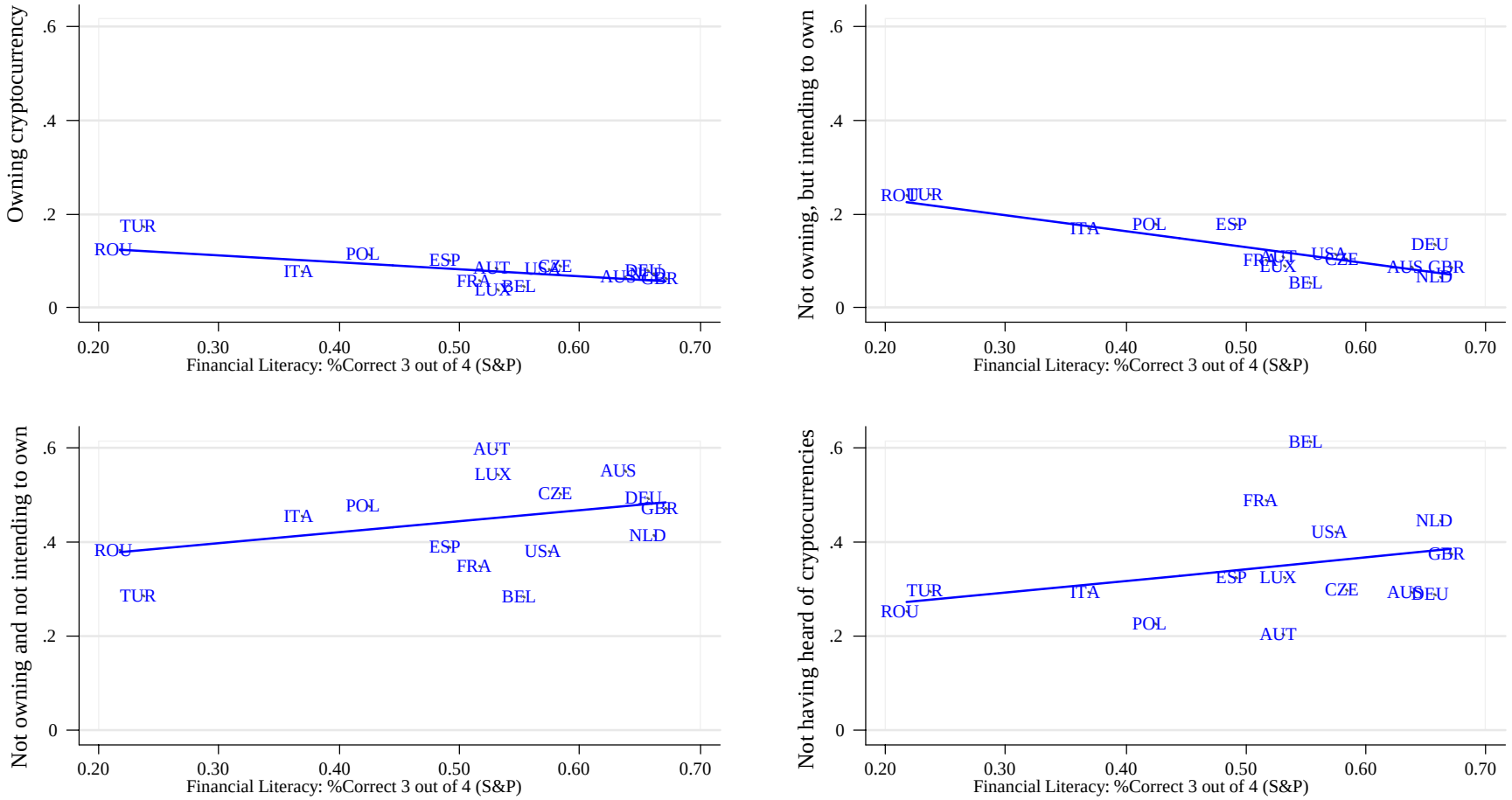


Figure 5
Attitudes to cryptocurrencies and financial literacy at the country level

This figure presents twoway scatterplots between the four response categories in the question regarding attitudes to cryptocurrencies, and financial literacy scores at the country level. Figures are weighted by GDP per capita (PPP current international $) from the World Bank's World Development Indicators. Financial literacy figures are from the S&P 2014 Global Financial Literacy Survey, and represent the percentage of individuals who responded correctly to at least 3 out of 4 concepts in each of the 15 counties in our sample.

Table 1
Weighted summary statistics

	(1)	(2)	(3)	(4)	(5)	(6)	
	All	**Owning**	**Intend to own**	**Not intend to own**	**Not having heard of**	**Difference: 1/2 – 3/4**	
	14,582	*1,261*	*1,907*	*6,370*	*5,044*		
	[100.0%]	*[8.7%]*	*[13.3%]*	*[43.5%]*	*[34.5%]*		
Financial literacy	0.518	0.486	0.469	0.533	0.525	-0.054	***
Technological literacy	0.471	0.574	0.540	0.461	0.429	0.106	***
Preference for cash/informality	0.824	0.897	0.907	0.805	0.797	0.101	***
Inflectional FTR/risk tolerance	0.327	0.359	0.407	0.280	0.348	0.078	***
Household income per capita	1,116.4	1,055.3	979.2	1,216.5	1,059.9	-140.0	***
Missing income	10.7%	4.5%	6.4%	10.7%	13.9%	-0.065	***
Male	49.0%	68.2%	60.6%	54.7%	32.4%	0.187	***
Age	44.45	38.45	38.93	46.67	45.31	-7.327	***
Young (<45)	49.7%	68.6%	64.8%	43.4%	47.1%	0.213	***
Married	51.0%	53.0%	49.1%	51.3%	50.7%	-0.004	
Single	21.4%	21.0%	25.4%	21.3%	20.0%	0.029	***
In a relationship	16.4%	19.0%	17.7%	15.6%	16.2%	0.023	***
Widowed/Divorced/Separated	11.3%	7.0%	7.8%	11.8%	13.1%	-0.049	***
Household size	2.63	2.88	2.86	2.52	2.62	0.302	***
Fin. advice: An independent financial advisor	19.2%	18.1%	28.4%	16.6%	16.6%	0.077	***
–"– My friends/family	7.8%	12.4%	11.3%	5.8%	5.8%	0.060	***
–"– The internet and specialist websites	26.6%	45.0%	39.6%	19.0%	19.0%	0.227	***
–"– An online computer program or algorithm for tailored advice	6.4%	15.3%	10.8%	3.3%	3.3%	0.093	***
–"– No financial advice	40.0%	9.2%	9.9%	55.3%	55.3%	-0.457	***
Reward perception	0.593	0.781	0.743	0.509	0.509	0.249	***
Risk perception	0.737	0.660	0.687	0.767	0.767	-0.091	***
Digital currencies – e.g. Bitcoin – are the future of spending online	2.958	3.928	3.758	2.519	2.519	1.307	***
–"– of investment as storage of value	2.907	3.867	3.709	2.469	2.469	1.302	***
I think the value of digital currencies – e.g. Bitcoin – will increase in the next 12 months	3.030	3.924	3.685	2.651	2.651	1.129	***
Cryptocurrency riskier than cash	3.886	3.497	3.649	4.036	4.036	-0.448	***
- " - bonds	3.712	3.292	3.470	3.870	3.870	-0.470	***
- " - stocks	3.283	2.907	2.945	3.462	3.462	-0.532	***
- " - real estate/funds	3.767	3.388	3.537	3.914	3.914	-0.437	***
- " - gold	3.919	3.543	3.751	4.046	4.046	-0.378	***
- " - investing in own business	3.527	3.163	3.270	3.678	3.678	-0.451	***
Ignorance of online payment methods	0.291	0.173	0.205	0.289	0.355	-0.126	***

This table reports weighted averages for all individuals in the ING 2018 International Survey on Mobile Banking (Column 1). It reports weighted averages for individuals owning cryptocurrency (Column 2), for individuals intending to own cryptocurrency in the future (Column 3), for those not intending to own (Column 4), and for individuals who have not heard of cryptocurrencies before (Column 5). Column 6 reports mean differences and asterisks for the levels of significance from weighted t-tests between individuals currently owning or expecting to own cryptocurrencies in the future and those not intending to own or who have not heard of cryptocurrencies before. Weighted t-tests and levels of significance are computed using the parmby and metaparm commands in Stata. The asterisks denote the following levels of significance: *** p<0.01, ** p<0.05, * p<0.1. The financial literacy variable is calculated as a individual average of the country financial literacy scores by gender, age group (15-34, 35-54, >55) and income (top 60%, bottom 40%) from the S&P 2014Global Financial Literacy Survey.

Table 2
Attitudes to cryptocurrencies and financial literacy

	Own	*Intend to own*	*Not intend to own*	*Not having heard of*
	(1)	(2)	(3)	(4)
Financial literacy	-0.230**	0.033	0.696***	-0.500***
	[0.107]	[0.124]	[0.181]	[0.167]
Technological literacy	0.566***	0.616***	-0.294***	-0.888***
	[0.056]	[0.066]	[0.100]	[0.092]
Inflectional FTR/risk tolerance	-0.006	0.127***	-0.031	-0.090***
	[0.018]	[0.023]	[0.027]	[0.023]
Preference for cash/informality	0.116**	0.052	-0.440***	0.271***
	[0.052]	[0.059]	[0.088]	[0.082]
Male	0.061***	0.048***	0.074***	-0.183***
	[0.006]	[0.007]	[0.010]	[0.009]
Log(Household income per capita)	-0.014	-0.014	-0.063**	0.091***
	[0.016]	[0.019]	[0.029]	[0.026]
Log(Household income per capita)^2	0.004	0.005	0.019**	-0.027***
	[0.004]	[0.005]	[0.008]	[0.007]
Log(Household income per capita)^3	-0.001	-0.001	-0.001**	0.002***
	[0.000]	[0.000]	[0.001]	[0.001]
Missing household income per capita	-0.039**	-0.018	0.033	0.024
	[0.020]	[0.022]	[0.031]	[0.027]
Age: 18-25	0.064***	0.069***	-0.157***	0.024
	[0.011]	[0.013]	[0.018]	[0.017]
–"– 26-35	0.067***	0.049***	-0.155***	0.039***
	[0.009]	[0.011]	[0.015]	[0.014]
–"– 36-45	0.036***	0.025**	-0.099***	0.038***
	[0.009]	[0.010]	[0.014]	[0.013]
–"– 46-55	0.023***	0.009	-0.056***	0.024*
	[0.009]	[0.010]	[0.014]	[0.013]
–"– 56-65	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}
–"– 66-75	-0.019	-0.048***	0.028	0.039**
	[0.014]	[0.016]	[0.018]	[0.016]
Married/Cohabiting/Civil partnership	0.005	-0.020**	-0.027**	0.043***
	[0.007]	[0.008]	[0.012]	[0.011]
In a relationship	0.008	-0.017*	-0.014	0.023*
	[0.008]	[0.009]	[0.014]	[0.012]
Widowed/Divorced/Separated	0.020*	0.004	-0.045***	0.022
	[0.011]	[0.012]	[0.016]	[0.015]
Single	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}
Household size	0.006**	0.010***	-0.015***	-0.001
	[0.003]	[0.003]	[0.005]	[0.004]
Pre-sixteen education	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}
A-levels, GNVQ or college	0.020**	-0.004	0.054***	-0.070***
	[0.010]	[0.010]	[0.014]	[0.012]
Higher vocational education or HND	0.028***	0.011	0.066***	-0.105***
	[0.010]	[0.011]	[0.016]	[0.014]
University (Bachelors)	0.029***	0.020*	0.124***	-0.174***
	[0.010]	[0.011]	[0.016]	[0.014]
Higher university degree	0.051***	0.015	0.146***	-0.212***
	[0.010]	[0.012]	[0.017]	[0.015]
Occupation: Self-Employed	0.049***	0.043***	-0.063**	-0.029
	[0.014]	[0.016]	[0.026]	[0.025]

Table 2 continued in next page

Table 2 continued from last page

	(1)	(2)	(3)	(4)
–"– Full-time employee	0.023**	0.008	-0.073***	0.043**
	[0.012]	[0.013]	[0.021]	[0.019]
–"– Part-time employee	0.024*	0.007	-0.078***	0.047**
	[0.013]	[0.014]	[0.023]	[0.021]
–"– Student	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}
–"– Unemployed	0.007	-0.007	-0.058**	0.058**
	[0.015]	[0.017]	[0.026]	[0.023]
–"– Inactive	0.009	-0.013	-0.058**	0.062***
	[0.015]	[0.016]	[0.024]	[0.022]
–"– Retired	0.016	-0.017	-0.073***	0.074***
	[0.016]	[0.017]	[0.025]	[0.023]
Country: Austria	0.009	0.136***	0.305***	-0.451***
	[0.016]	[0.024]	[0.026]	[0.023]
–"– Belgium	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}
–"– France	-0.012	0.003	0.078***	-0.068***
	[0.019]	[0.020]	[0.028]	[0.024]
–"– Germany	0.029	0.148***	0.110***	-0.287***
	[0.020]	[0.028]	[0.033]	[0.029]
–"– Italy	-0.032	0.049*	0.313***	-0.330***
	[0.026]	[0.029]	[0.042]	[0.038]
–"– Luxembourg	-0.051***	0.032	0.254***	-0.235***
	[0.020]	[0.024]	[0.028]	[0.026]
–"– Netherlands	0.041**	0.073**	0.038	-0.151***
	[0.020]	[0.029]	[0.033]	[0.029]
–"– Spain	0.004	0.047**	0.163***	-0.214***
	[0.019]	[0.020]	[0.029]	[0.025]
–"– United Kingdom	0.006	0.088***	0.092***	-0.185***
	[0.020]	[0.028]	[0.033]	[0.029]
–"– Poland	0.008	0.194***	0.295***	-0.497***
	[0.020]	[0.028]	[0.034]	[0.031]
–"– Romania	-0.04	0.229***	0.350***	-0.539***
	[0.038]	[0.046]	[0.064]	[0.058]
–"– Czech Republic	0.046**	0.141***	0.266***	-0.453***
	[0.020]	[0.029]	[0.034]	[0.030]
–"– Turkey	-0.001	0.095**	0.287***	-0.381***
	[0.037]	[0.042]	[0.062]	[0.057]
–"– Australia	0.025	0.107***	0.169***	-0.302***
	[0.019]	[0.028]	[0.032]	[0.028]
–"– USA	0.011	0.124***	0.064**	-0.200***
	[0.016]	[0.024]	[0.027]	[0.022]
Predicted probability	*0.0874*	*0.1324*	*0.4351*	*0.3451*
%Fin. literacy effect	*-24.1%*	*0.5%*	*15.9%*	*-13.9%*
%Interquartile-change effect	*-38.1%*	*2.3%*	*32.7%*	*-22.7%*
#Observations		14,582		
Log-likelihood		-15,671.2		
Wald χ^2		3,326.2***		

This table reports estimates of the determinants of attitudes to cryptocurrencies from a weighted multinomial probit regression. Marginal effects for the four categories of the variable on attitudes to cryptocurrencies and robust standard errors are presented in brackets. The specification also includes a constant term. The % Fin. Literacy effect is calculated as the change in the predicted probability by an increase in the financial literacy score from 0.5177 to 0.61.77. The %Interquartile-change effect is calculated as the change in the predicted probability by an increase in financial literacy from 0.442 to 0.6233. The asterisks denote the following levels of significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 3
The interaction between financial-literacy and countries

	Own	*Intend to own*	*Not intend to own*	*Not having heard of*
	(1)	(2)	(3)	(4)
Financial literacy	-1.117**	0.140	3.430***	-2.453***
	[0.557]	[0.785]	[0.912]	[0.753]
Austria	-1.110***	0.102	1.744***	-0.737
	[0.361]	[0.504]	[0.608]	[0.532]
Belgium	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}
France	-0.494	0.141	1.929***	-1.576***
	[0.362]	[0.489]	[0.593]	[0.487]
Germany	-0.571*	0.204	1.852***	-1.485***
	[0.342]	[0.469]	[0.557]	[0.470]
Italy	-0.425	0.040	1.991***	-1.606***
	[0.324]	[0.453]	[0.528]	[0.437]
Luxembourg	-0.907*	0.314	1.405**	-0.812
	[0.506]	[0.540]	[0.653]	[0.577]
The Netherlands	-0.662*	-0.092	1.585***	-0.831*
	[0.371]	[0.520]	[0.590]	[0.490]
Spain	-0.446	-0.090	1.236**	-0.700
	[0.359]	[0.486]	[0.606]	[0.513]
United Kingdom	-1.004	1.258	0.438	-0.692
	[0.671]	[0.793]	[1.019]	[0.890]
Poland	-0.409	0.246	1.711***	-1.548***
	[0.335]	[0.466]	[0.553]	[0.470]
Romania	-0.375	0.506	1.736***	-1.868***
	[0.329]	[0.462]	[0.549]	[0.460]
Czech Republic	-0.699*	0.298	0.501	-0.100
	[0.385]	[0.523]	[0.640]	[0.555]
Turkey	-0.366	0.372	1.640***	-1.646***
	[0.324]	[0.458]	[0.546]	[0.453]
Australia	-0.544	0.141	1.960***	-1.557***
	[0.335]	[0.470]	[0.548]	[0.458]
USA	-0.430	0.061	2.070***	-1.701***
	[0.340]	[0.476]	[0.566]	[0.467]
Fin. literacy*Austria	2.023***	0.071	-2.513**	0.418
	[0.643]	[0.894]	[1.087]	[0.961]
Fin. literacy*Belgium	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}
Fin. literacy*France	0.838	-0.256	-3.314***	2.732***
	[0.648]	[0.870]	[1.066]	[0.879]
Fin. literacy*Germany	1.024*	-0.101	-3.013***	2.090***
	[0.587]	[0.808]	[0.957]	[0.805]
Fin. literacy*Italy	0.591	0.073	-3.084***	2.420***
	[0.588]	[0.811]	[0.962]	[0.808]
Fin. literacy*Luxembourg	1.531*	-0.513	-1.984*	0.966
	[0.907]	[0.966]	[1.172]	[1.048]
Fin. literacy*Netherlands	1.175*	0.221	-2.717***	1.321
	[0.620]	[0.870]	[0.996]	[0.827]
Fin. literacy*Spain	0.774	0.292	-1.782	0.717
	[0.651]	[0.872]	[1.109]	[0.948]
Fin. literacy*United Kingdom	1.632	-1.751	-0.949	1.068
	[1.034]	[1.245]	[1.582]	[1.375]
Fin. literacy*Poland	0.684	-0.088	-2.420**	1.823**
	[0.618]	[0.842]	[1.028]	[0.895]

Table 3 continued in next page

Table 3 continued from last page

	(1)	(2)	(3)	(4)
Fin. literacy*Romania	0.133	-1.063	-2.009	2.938***
	[0.705]	[0.931]	[1.244]	[1.092]
Fin. literacy*Czech Republic	1.301*	-0.258	-0.489	-0.554
	[0.667]	[0.905]	[1.110]	[0.966]
Fin. literacy*Turkey	0.292	-1.013	-1.935	2.656**
	[0.647]	[0.908]	[1.202]	[1.039]
Fin. literacy*Australia	0.983*	-0.068	-3.099***	2.183***
	[0.580]	[0.812]	[0.949]	[0.793]
Fin. literacy*USA	0.777	0.102	-3.510***	2.631***
	[0.594]	[0.830]	[0.989]	[0.820]
%Fin. literacy effect	*-56.2%*	*-5.0%*	*57.4%*	*-40.8%*
%Interquartile-change effect	*-72.4%*	*2.7%*	*147.0%*	*-53.7%*
#Observations		14,582		
Log-likelihood		-15,625.2		
Wald χ^2		3,356.0***		

This table reports selected estimates of the determinants of attitudes to cryptocurrencies from a weighted multinomial probit regression. Marginal effects for the four categories of the variable on attitudes to cryptocurrencies and robust standard errors are presented in brackets. The remaining specification is identical to that of Table 2, and it also incorporates 15 interaction terms between financial literacy and country.

Table 4
Robustness exercises

	Own	*Intend to own*	*Not intend to own*	*Not having heard of*
Panel A: Bootstrapped standard errors	(A_1)	(A_2)	(A_3)	(A_4)
Financial literacy	-0.230*	0.033	0.696**	-0.500***
	[0.139]	[0.267]	[0.321]	[0.085]
%Fin. literacy effect	*-24.1%*	*0.5%*	*15.9%*	*-13.9%*
%Interquartile-change effect	*-38.1%*	*2.3%*	*32.7%*	*-22.7%*
Panel B: Bootstrapped estimation	(B_1)	(B_2)	(B_3)	(B_4)
Financial literacy	-0.212**	0.030	0.680***	-0.499***
	[0.102]	[0.125]	[0.188]	[0.170]
%Fin. literacy effect	*-23.1%*	*0.1%*	*15.1%*	*-14.1%*
%Interquartile-change effect	*-42.5%*	*2.2%*	*39.8%*	*-27.3%*
Panel C: Unweighted estimation	(C_1)	(C_2)	(C_3)	(C_4)
Financial literacy	-0.210**	0.030	0.680***	-0.500***
	[0.105]	[0.122]	[0.179]	[0.166]
%Fin. literacy effect	*-23.2%*	*0.0%*	*15.1%*	*-14.1%*
%Interquartile-change effect	*-42.6%*	*2.1%*	*39.9%*	*-27.3%*
Panel D: High financial-literacy by country indicator	(D_1)	(D_2)	(D_3)	(D_4)
High financial literacy by country	-0.014**	0.001	0.043***	-0.031***
	[0.006]	[0.007]	[0.010]	[0.009]
%Fin. literacy effect	*-16.0%*	*0.8%*	*9.9%*	*-9.0%*
Predicted probability	*0.0874*	*0.1324*	*0.4351*	*0.3451*
Panel E: Logarithmic financial literacy	(E_1)	(E_2)	(E_3)	(E_4)
Log(Financial literacy)	-0.152***	-0.043	0.325***	-0.130
	[0.048]	[0.057]	[0.085]	[0.079]
%Fin. literacy effect	*-27.6%*	*-7.5%*	*12.5%*	*-7.1%*
%Interquartile-change effect	*-45.3%*	*-12.9%*	*27.6%*	*-12.4%*
Panel F: Alternative financial-literacy measure I	(F_1)	(F_2)	(F_3)	(F_4)
$FL_i^1 = \prod \frac{FL_{gender} FL_{age} FL_{income}}{FL_{country}^2}$	-0.066**	0.006	0.229***	-0.170***
	[0.033]	[0.039]	[0.057]	[0.054]
%Interquartile-change effect	*-15.5%*	*0.9%*	*12.6%*	*-10.4%*
Panel G: Alternative financial-literacy measure II	(G_1)	(G_2)	(G_3)	(G_4)
$FL_i^2 = \prod \prod \frac{FL_{gender} FL_{age} FL_{income}}{FL_{country}^3}$	-0.043***	-0.012	0.103***	-0.048*
	[0.015]	[0.017]	[0.026]	[0.025]
%Interquartile-change effect	*-12.5%*	*-2.4%*	*6.8%*	*-3.8%*
Panel H: Male sub-sample	(H_1)	(H_2)	(H_3)	(H_4)
Financial literacy	-0.403**	-0.295	1.118***	-0.420*
	[0.196]	[0.220]	[0.297]	[0.246]
%Fin. literacy effect	*-29.6%*	*-19.2%*	*22.0%*	*-17.3%*
%Interquartile-change effect	*-44.9%*	*-29.8%*	*47.8%*	*-27.0%*
Panel I: Female sub-sample	(I_1)	(I_2)	(I_3)	(I_4)
Financial literacy	-0.177	0.103	0.598**	-0.525*
	[0.133]	[0.169]	[0.273]	[0.279]
%Fin. literacy effect	*-29.3%*	*7.5%*	*15.2%*	*-11.2%*
%Interquartile-change effect	*-44.4%*	*16.0%*	*31.4%*	*-17.9%*

This table reports estimates of the effect of financial literacy on attitudes to cryptocurrencies from 9 distinctive weighted multinomial probit regressions. Marginal effects for the four categories of the variable on attitudes to cryptocurrencies and robust standard errors are presented in brackets. The remaining specification of all models is identical to that of Table 2.

Table 5
Weighted multinomial probit model with selection

	Own	***Intend to own***	***Not intend to own***	**Selection equation: Having heard of**
	(A_1)	(A_2)	(A_3)	(S_1)
Financial literacy	-0.373***	-0.159	0.246**	0.541***
	[0.092]	[0.097]	[0.097]	[0.166]
Technological literacy	0.099**	0.076	-0.560***	0.781***
	[0.049]	[0.053]	[0.053]	[0.093]
Preference for cash/informality	0.191***	0.149***	-0.195***	-0.289***
	[0.045]	[0.048]	[0.048]	[0.081]
Inflectional FTR/risk tolerance	-0.041***	0.063***	-0.061***	0.071***
	[0.015]	[0.018]	[0.017]	[0.023]
Male	-0.025***	-0.042***	-0.023***	0.177***
	[0.005]	[0.005]	[0.005]	[0.009]
Log(Household income per capita)	0.022	0.026*	-0.009	-0.081***
	[0.015]	[0.015]	[0.016]	[0.026]
Log(Household income per capita)^2	-0.007*	-0.007*	0.003	0.024***
	[0.004]	[0.004]	[0.004]	[0.007]
Log(Household income per capita)^3	0.001*	0.001	0.001	-0.002***
	[0.000]	[0.000]	[0.000]	[0.001]
Missing household income per capita	-0.021	-0.003	0.034*	-0.022
	[0.017]	[0.017]	[0.018]	[0.026]
Ignorance of online payment methods	–	–	–	-0.166***
				[0.012]
%Fin. literacy effect	*-15.6%*	*-7.0%*	*5.4%*	*7.9%*
%Interquartile-change effect	*-25.5%*	*-11.5%*	*10.2%*	*15.5%*
#Observations		14,582		
Log-likelihood		-15,551.8		
Wald χ^2		2,961.6***		

This table reports selected estimates of the determinants of attitudes to cryptocurrencies from a weighted multinomial probit regression with a first stage selection equation modelling the probability to have heard of cryptocurrencies before. Marginal effects for the three categories of the variable on attitudes to cryptocurrencies (Owning; Intending to own in the future, and; Not intending to own in the future) are presented, along with robust standard errors in brackets. The specification is identical to Table 2 and includes a constant term. The selection equation is identified via an exclusion restriction capturing ignorance of online payments, in terms of knowledge of the following providers, as options to pay for goods and services in the near future, either in store or online: ApplePay, Google/AndroidPay, PayPal, Facebook, AmazonPay (Amazon account), and own bank's app. It is a continuous index, ranging between 0 and 1, and stemming from the summation of unawareness of the six providers, divided by 6.

Table 6
Interactions between financial literacy and (i) technological literacy; (ii) preference for cash

	Own	*Intend to own*	*Not intend to own*	*Not having heard of*	*Own*	*Intend to own*	*Not intend to own*	*Not having heard of*
	(A_1)	(A_2)	(A_3)	(A_4)	(B_1)	(B_2)	(B_3)	(B_4)
Financial literacy	-0.233**	-0.001	0.766***	-0.533***	-0.266**	-0.039	0.773***	-0.467***
	[0.116]	[0.132]	[0.192]	[0.178]	[0.110]	[0.128]	[0.186]	[0.173]
Technological literacy	0.110***	0.094**	0.012	-0.216***	0.113***	0.122***	-0.058***	-0.177***
	[0.034]	[0.041]	[0.070]	[0.067]	[0.011]	[0.013]	[0.020]	[0.018]
Fin. literacy*Tech. literacy	0.005	0.059	-0.136	0.072	–	–	–	–
	[0.067]	[0.079]	[0.130]	[0.124]				
Preference for cash/informality	0.012**	0.005	-0.044***	0.027***	-0.013	-0.042**	0.007	0.048
	[0.005]	[0.006]	[0.009]	[0.008]	[0.017]	[0.020]	[0.032]	[0.030]
Fin. literacy*Preference for cash	–	–	–	–	0.048	0.095**	-0.101*	-0.043
					[0.033]	[0.039]	[0.059]	[0.056]
Inflectional FTR/risk tolerance	-0.006	0.127***	-0.031	-0.090***	-0.007	0.126***	-0.03	-0.090***
	[0.018]	[0.023]	[0.027]	[0.023]	[0.018]	[0.023]	[0.027]	[0.023]
Male	0.061***	0.048***	0.074***	-0.183***	0.061***	0.047***	0.075***	-0.183***
	[0.006]	[0.007]	[0.010]	[0.009]	[0.006]	[0.007]	[0.010]	[0.009]
Log(Household income p.c.)	-0.014	-0.015	-0.061**	0.090***	-0.013	-0.012	-0.065**	0.090***
	[0.016]	[0.019]	[0.029]	[0.026]	[0.016]	[0.019]	[0.029]	[0.026]
Log(Household income p.c.)^2	0.004	0.005	0.018**	-0.027***	0.003	0.004	0.020**	-0.027***
	[0.004]	[0.005]	[0.008]	[0.007]	[0.004]	[0.005]	[0.008]	[0.007]
Log(Household income p.c.)^3	-0.001	-0.001	-0.001**	0.002***	-0.001	-0.001	-0.001**	0.002***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Missing household income	-0.039**	-0.018	0.033	0.024	-0.039**	-0.018	0.033	0.024
	[0.020]	[0.022]	[0.031]	[0.027]	[0.020]	[0.022]	[0.031]	[0.027]
%Fin. literacy effect	*-24.5%*	*-2.2%*	*17.5%*	*-14.7%*	*-27.3%*	*-5.0%*	*17.6%*	*-13.2%*
%Interquartile-change effect	*-38.5%*	*-2.4%*	*36.3%*	*-23.9%*	*-42.5%*	*-7.4%*	*36.7%*	*-21.4%*
#Observations	14,582				14,582			
Log-likelihood	-15,670.5				-15,665.8			
Wald χ^2	3,324.5***				3,332.2***			

This table reports selected estimates of the determinants of attitudes to cryptocurrencies from two weighted multinomial probit regressions. Marginal effects for the four categories of the variable on attitudes to cryptocurrencies are presented in Columns A_1 - A_4 and Columns B_1 - B_4, respectively, along with robust standard errors in brackets. The first model (A_1 - A_4) incorporates an interaction term between financial literacy and technological literacy. The second model (B_1 - B_4) incorporates an interaction term between financial literacy and preference for cash. The remaining specification is identical to that of Table 2.

Table 7
Interactions between financial literacy and age

	Own	*Intend to own*	*Not intend to own*	*Not having heard of*	*Own*	*Intend to own*	*Not intend to own*	*Not having heard of*
	(A_1)	(A_2)	(A_3)	(A_4)	(B_1)	(B_2)	(B_3)	(B_4)
Financial literacy	-0.199*	0.059	0.616***	-0.476***	-0.193*	0.098	0.701***	-0.606***
	[0.107]	[0.124]	[0.180]	[0.166]	[0.114]	[0.134]	[0.191]	[0.177]
Young age (<45)	-0.030*	-0.047**	-0.043	0.120***	–	–	–	–
	[0.016]	[0.020]	[0.032]	[0.029]				
Fin. Literacy*Young age	0.136***	0.166***	-0.110*	-0.193***	–	–	–	–
	[0.031]	[0.037]	[0.057]	[0.053]				
Age: 18-25	–	–	–	–	-0.079***	-0.035	-0.061	0.174***
					[0.029]	[0.034]	[0.054]	[0.050]
–"– 26-35	–	–	–	–	-0.019	-0.062**	-0.044	0.125***
					[0.025]	[0.032]	[0.050]	[0.047]
–"– 36-45	–	–	–	–	-0.029	-0.03	-0.034	0.093**
					[0.025]	[0.031]	[0.049]	[0.046]
–"– 46-55	–	–	–	–	-0.006	-0.003	0.031	-0.021
					[0.027]	[0.032]	[0.049]	[0.047]
–"– 56-65	–	–	–	–	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}
–"– 66-75	–	–	–	–	-0.019	-0.04	-0.021	0.08
					[0.043]	[0.048]	[0.072]	[0.066]
Fin. literacy*Age: 18-25	–	–	–	–	0.279***	0.206***	-0.192*	-0.294***
					[0.053]	[0.064]	[0.098]	[0.092]
Fin. literacy*Age: 26-35	–	–	–	–	0.166***	0.220***	-0.220**	-0.166*
					[0.049]	[0.059]	[0.092]	[0.087]
Fin. literacy*Age: 36-45	–	–	–	–	0.126***	0.108*	-0.13	-0.104
					[0.047]	[0.058]	[0.088]	[0.083]
Fin. literacy*Age: 46-55	–	–	–	–	0.058	0.021	-0.168*	0.089
					[0.050]	[0.061]	[0.090]	[0.086]
Fin. literacy*Age: 56-65	–	–	–	–	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}
Fin. literacy*Age: 66-75	–	–	–	–	0.016	-0.006	0.076	-0.086
					[0.078]	[0.089]	[0.126]	[0.115]
Technological literacy	0.116***	0.126***	-0.066***	-0.176***	0.111***	0.122***	-0.059***	-0.175***
	[0.011]	[0.013]	[0.020]	[0.018]	[0.011]	[0.013]	[0.020]	[0.018]
Preference for cash/informality	0.012**	0.007	-0.045***	0.026***	0.012**	0.006	-0.045***	0.026***
	[0.005]	[0.006]	[0.009]	[0.008]	[0.005]	[0.006]	[0.009]	[0.008]
Inflectional FTR/risk tolerance	-0.006	0.127***	-0.03	-0.090***	-0.006	0.129***	-0.032	-0.091***
	[0.018]	[0.023]	[0.027]	[0.023]	[0.018]	[0.023]	[0.027]	[0.023]
Male	0.058***	0.044***	0.079***	-0.181***	0.056***	0.042***	0.079***	-0.177***
	[0.006]	[0.007]	[0.010]	[0.009]	[0.006]	[0.007]	[0.010]	[0.009]
%Fin. literacy effect	*-21.2%*	*2.7%*	*14.1%*	*-13.2%*	*-20.8%*	*5.1%*	*15.9%*	*-16.4%*
%Interquartile-change effect	*-34.0%*	*6.2%*	*28.6%*	*-21.8%*	*-33.1%*	*11.1%*	*32.8%*	*-26.5%*
#Observations		14,582				14,582		
Log-likelihood		-15,686.4				-15,630.1		
Wald χ^2		3,298.6***				3,356.3***		

This table reports selected estimates of the determinants of attitudes to cryptocurrencies from two weighted multinomial probit regressions. Marginal effects for the four categories of the variable on attitudes to cryptocurrencies are presented in Columns A_1 - A_4 and Columns B_1 - B_4, respectively, along with robust standard errors in brackets. The first model (A_1 - A_4) incorporates an interaction term between financial literacy and young age (<45). The second model (B_1 - B_4) incorporates six interaction term between financial literacy and six age

categories. namely 18-25, 26-35, 36-45, 46-55. 56-65 (reference group), 66-75. The remaining specification is identical to that of Table 2.

Table 8
The interactions between financial literacy and sources of financial advice for investment

	Own	***Intend to own***	***Not intend to own***	***Own***	***Intend to own***	***Not intend to own***
	(A_1)	(A_2)	(A_3)	(B_1)	(B_2)	(B_3)
Financial literacy	-0.428***	-0.090	0.518***	-0.403**	-0.161	0.563***
	[0.153]	[0.175]	[0.189]	[0.161]	[0.184]	[0.195]
Fin. advice: Independent financial or bank advisor	0.076***	0.215***	-0.291***	0.059	0.173***	-0.232***
	[0.011]	[0.012]	[0.011]	[0.041]	[0.041]	[0.043]
–"– My friends/family	0.134***	0.215***	-0.349***	0.100**	0.111**	-0.211***
	[0.013]	[0.015]	[0.015]	[0.047]	[0.056]	[0.059]
–"– The internet and specialist websites	0.146***	0.215***	-0.361***	0.201***	0.159***	-0.360***
	[0.009]	[0.011]	[0.010]	[0.035]	[0.038]	[0.039]
–"– An online computer program or algorithm for tailored advice	0.196***	0.244***	-0.439***	0.154***	0.232***	-0.386***
	[0.013]	[0.015]	[0.016]	[0.044]	[0.052]	[0.058]
–"– No financial advice	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}
Fin. literacy*Fin. advice: An independent financial or bank advisor	–	–	–	0.033	0.086	-0.119
				[0.078]	[0.081]	[0.084]
Fin. literacy*Fin. advice: My friends/family	–	–	–	0.062	0.204*	-0.266**
				[0.087]	[0.105]	[0.109]
Fin. literacy*Fin. advice: The internet and specialist websites	–	–	–	-0.112*	0.115	-0.003
				[0.067]	[0.074]	[0.075]
Fin. literacy*Fin. advice: An online computer program or algorithm for tailored advice	–	–	–	0.084	0.020	-0.104
				[0.085]	[0.102]	[0.111]
Fin. literacy* No financial advice	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}	{*Ref.*}
Technological literacy	0.107***	0.073***	-0.179***	0.105***	0.074***	-0.179***
	[0.016]	[0.019]	[0.020]	[0.016]	[0.019]	[0.020]
Preference for cash/informality	0.016**	0.007	-0.023**	0.015*	0.007	-0.022**
	[0.008]	[0.009]	[0.009]	[0.008]	[0.009]	[0.009]
Inflectional FTR/risk tolerance	-0.037	0.186***	-0.148***	-0.039	0.187***	-0.148***
	[0.028]	[0.035]	[0.035]	[0.028]	[0.035]	[0.035]
Male	0.052***	0.008	-0.060***	0.052***	0.008	-0.060***
	[0.008]	[0.010]	[0.010]	[0.008]	[0.010]	[0.010]
Log(Household income per capita)	-0.011	0.006	0.005	-0.012	0.007	0.005
	[0.024]	[0.028]	[0.031]	[0.024]	[0.028]	[0.031]
Log(Household income per capita)^2	0.001	-0.003	0.002	0.001	-0.003	0.002
	[0.006]	[0.008]	[0.008]	[0.006]	[0.008]	[0.008]
Log(Household income per capita)^3	-0.001	0.001	-0.001	-0.001	0.001	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Missing household income per capita	-0.054*	-0.012	0.065*	-0.054*	-0.013	0.067*
	[0.029]	[0.032]	[0.035]	[0.029]	[0.032]	[0.035]
%Fin. literacy effect	*-28.4%*	*-6.0%*	*7.5%*	*-27.2%*	*-9.3%*	*8.2%*
%Interquartile-change effect	*-44.2%*	*-9.5%*	*15.1%*	*-42.6%*	*-15.0%*	*16.4%*
#Observations		9,538			9,538	
Log-likelihood		-6,724.1			-6,713.9	
Wald χ^2		2,347.1***			2,340.1***	

This table reports selected estimates of the determinants of attitudes to cryptocurrencies from two weighted multinomial probit regressions for the sub-sample of individuals who have heard of cryptocurrencies before. Marginal effects for the remaining three categories of the variable on attitudes to cryptocurrencies are presented in Columns A_1 - A_3 and Columns B_1 - B_3, respectively, along with robust standard errors in brackets. The first model (A_1 - A_3) incorporates five variables capturing distinctive sources of financial advice on cryptocurrencies among individuals who have heard of them. The

second model (B_1 - B_3) also incorporates five interaction terms between financial literacy and the sources of financial advice on cryptocurrencies. The remaining specification is identical to that of Table 2.

Table 9
The interactions between financial literacy and the perception of rewards from cryptocurrencies

	Own	***Intend to own***	***Not intend to own***	***Own***	***Intend to own***	***Not intend to own***
	($\underline{A_1}$)	($\underline{A_2}$)	($\underline{A_3}$)	($\underline{B_1}$)	($\underline{B_2}$)	($\underline{B_3}$)
Financial literacy	-0.390**	0.063	0.327*	-0.338*	-0.082	0.420**
	[0.152]	[0.170]	[0.173]	[0.179]	[0.192]	[0.204]
Digital currencies – e.g. Bitcoin – are the future of spending online	0.035***	0.053***	-0.088***	0.041**	0.028	-0.069***
	[0.005]	[0.006]	[0.006]	[0.017]	[0.020]	[0.020]
–"– are the future of investment as storage of value	0.025***	0.051***	-0.075***	0.051***	0.048**	-0.099***
	[0.005]	[0.006]	[0.006]	[0.017]	[0.021]	[0.021]
I think the value of digital currencies – e.g. Bitcoin – will increase in the next 12 months	0.036***	0.015***	-0.052***	0.013	0.021	-0.033*
	[0.005]	[0.005]	[0.005]	[0.015]	[0.017]	[0.018]
Fin. literacy*Future of spending online	–	–	–	-0.013	0.05	-0.037
				[0.032]	[0.038]	[0.038]
Fin. literacy*Future of investment or storage of value	–	–	–	-0.051	0.006	0.045
				[0.033]	[0.040]	[0.039]
Fin. literacy*The value will increase in next 12 months	–	–	–	0.047	-0.011	-0.036
				[0.029]	[0.033]	[0.034]
Technological literacy	0.079***	0.056***	-0.135***	0.079***	0.055***	-0.134***
	[0.016]	[0.018]	[0.019]	[0.016]	[0.018]	[0.019]
Preference for cash/informality	0.002	-0.002	0.001	0.003	-0.002	0.001
	[0.007]	[0.008]	[0.009]	[0.007]	[0.008]	[0.009]
Inflectional FTR/risk tolerance	-0.065**	0.165***	-0.099***	-0.066**	0.165***	-0.099***
	[0.028]	[0.036]	[0.033]	[0.027]	[0.036]	[0.033]
Male	0.065***	0.022**	-0.087***	0.065***	0.022**	-0.087***
	[0.008]	[0.009]	[0.009]	[0.008]	[0.009]	[0.009]
Log(Household income per capita)	0.001	0.01	-0.011	-0.001	0.012	-0.011
	[0.024]	[0.027]	[0.029]	[0.024]	[0.028]	[0.029]
Log(Household income per capita)^2	-0.001	-0.004	0.005	-0.001	-0.004	0.005
	[0.006]	[0.007]	[0.008]	[0.006]	[0.007]	[0.008]
Log(Household income per capita)^3	0.001	0.001	-0.001	0.001	0.001	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Missing household income per capita	-0.024	-0.013	0.037	-0.024	-0.013	0.037
	[0.028]	[0.031]	[0.032]	[0.028]	[0.031]	[0.032]
%Fin. literacy effect	*-26.1%*	*1.7%*	*4.7%*	*-23.2%*	*-5.1%*	*6.2%*
%Interquartile-change effect	*-41.2%*	*4.1%*	*9.4%*	*-37.3%*	*-8.3%*	*12.1%*
#Observations		9,538			9,538	
Log-likelihood		-6,084.6			-6,080.4	
Wald χ^2		2,323.6***			2,313.5***	

This table reports selected estimates of the determinants of attitudes to cryptocurrencies from two weighted multinomial probit regressions for the sub-sample of individuals who have heard of cryptocurrencies before. Marginal effects for the remaining three categories of the variable on attitudes to cryptocurrencies are presented in Columns A_1 - A_3 and Columns B_1 - B_3, respectively, along with robust standard errors in brackets. The first model (A_1 - A_3) incorporates three variables capturing reward perceptions on cryptocurrencies among the individuals who have heard of them. The second model (B_1 - B_3) also incorporates three interaction terms between financial literacy and the reward perceptions on cryptocurrencies. The remaining specification is identical to that of Table 2.

Table 10
The interaction between financial literacy and the risk perception

	Own	*Intend to own*	*Not intend to own*	*Own*	*Intend to own*	*Not intend to own*
	(A_1)	(A_2)	(A_3)	(B_1)	(B_2)	(B_3)
Financial literacy	-0.380**	-0.014	0.394**	-0.245	0.048	0.197
	[0.156]	[0.180]	[0.200]	[0.173]	[0.203]	[0.229]
Cryptocurrency riskier than cash	-0.007*	-0.011***	0.018***	-0.011	0.002	0.009
	[0.004]	[0.004]	[0.005]	[0.011]	[0.014]	[0.016]
- " - bonds	-0.009**	0.001	0.009*	-0.008	-0.001	0.009
	[0.004]	[0.004]	[0.005]	[0.012]	[0.014]	[0.016]
- " - stocks	-0.012***	-0.031***	0.043***	-0.027**	-0.019	0.046***
	[0.003]	[0.004]	[0.005]	[0.011]	[0.013]	[0.015]
- " - real estate/property funds	-0.003	0.002	0.001	0.030**	-0.012	-0.018
	[0.004]	[0.005]	[0.005]	[0.012]	[0.015]	[0.017]
- " - gold	-0.005	0.008*	-0.003	0.019	0.003	-0.022
	[0.004]	[0.004]	[0.005]	[0.012]	[0.015]	[0.017]
- " - investing in own business	-0.007**	-0.012***	0.019***	-0.032***	-0.006	0.037**
	[0.004]	[0.004]	[0.005]	[0.011]	[0.013]	[0.015]
Fin. literacy* Crypto. riskier than cash	–	–	–	0.009	-0.027	0.018
				[0.022]	[0.027]	[0.030]
- " - bonds	–	–	–	-0.003	0.003	0.001
				[0.023]	[0.028]	[0.032]
- " - stocks	–	–	–	0.032	-0.025	-0.007
				[0.022]	[0.026]	[0.029]
- " - real estate/property funds	–	–	–	-0.067***	0.03	0.037
				[0.023]	[0.029]	[0.032]
- " - gold	–	–	–	-0.048**	0.011	0.037
				[0.024]	[0.029]	[0.033]
- " - investing in own business	–	–	–	0.049**	-0.013	-0.036
				[0.022]	[0.026]	[0.029]
Technological literacy	0.127***	0.124***	-0.251***	0.127***	0.124***	-0.252***
	[0.016]	[0.019]	[0.021]	[0.016]	[0.019]	[0.021]
Preference for cash/informality	0.016**	0.012	-0.028***	0.015*	0.013	-0.028***
	[0.008]	[0.009]	[0.010]	[0.008]	[0.009]	[0.010]
Inflectional FTR/risk tolerance	-0.045	0.187***	-0.142***	-0.046	0.187***	-0.141***
	[0.028]	[0.037]	[0.037]	[0.028]	[0.037]	[0.037]
Male	0.064***	0.020**	-0.084***	0.064***	0.019*	-0.083***
	[0.009]	[0.010]	[0.011]	[0.009]	[0.010]	[0.011]
%Fin. literacy effect	*-25.6%*	*-1.8%*	*5.7%*	*-17.3%*	*1.9%*	*2.8%*
%Interquartile-change effect	*-40.6%*	*-2.5%*	*11.3%*	*-28.7%*	*3.8%*	*5.5%*
#Observations		9,538			9,538	
Log-likelihood		-7,274.2			-7,260.8	
Wald χ^2		1,623.5***			1,671.1***	

This table reports selected estimates of the determinants of attitudes to cryptocurrencies from two weighted multinomial probit regressions for the sub-sample of individuals who have heard of cryptocurrencies before. Marginal effects for the remaining three categories of the variable on attitudes to cryptocurrencies are presented in Columns A_1 - A_3 and Columns B_1 - B_3, respectively, along with robust standard errors in brackets. The first model (A_1 - A_3) incorporates six variables capturing risk perceptions on cryptocurrencies among the individuals who have heard of them. The second model (B_1 - B_3) also incorporates six interaction terms between financial literacy and the risk perceptions on cryptocurrencies. The remaining specification is identical to that of Table 2.

Table 11
The interaction between financial literacy and perceptions of reward and risk

	Own	*Intend to own*	*Not intend to own*	*Own*	*Intend to own*	*Not intend to own*
	(A_1)	(A_2)	(A_3)	(B_1)	(B_2)	(B_3)
Financial literacy	-0.381**	0.054	0.326*	-0.095	-0.085	0.180
	[0.151]	[0.169]	[0.172]	[0.217]	[0.236]	[0.253]
Digital currencies – e.g. Bitcoin – are the future of spending online	0.034***	0.053***	-0.087***	0.043**	0.025	-0.068***
	[0.005]	[0.006]	[0.006]	[0.017]	[0.020]	[0.020]
–"– are the future of investment as storage of value	0.024***	0.051***	-0.074***	0.053***	0.051**	-0.105***
	[0.005]	[0.006]	[0.006]	[0.018]	[0.021]	[0.021]
I think the value of digital currencies – e.g. Bitcoin – will increase in the next 12 months	0.036***	0.015***	-0.051***	0.015	0.020	-0.035**
	[0.005]	[0.005]	[0.005]	[0.015]	[0.017]	[0.018]
Fin. literacy*Future of spending online	–	–	–	-0.019	0.056	-0.036
				[0.032]	[0.038]	[0.039]
Fin. literacy*Future of investment or storage of value	–	–	–	-0.058*	-0.001	0.059
				[0.033]	[0.040]	[0.040]
Fin. literacy*The value will increase in next 12 months	–	–	–	0.042	-0.010	-0.032
				[0.029]	[0.033]	[0.034]
Fin. literacy* Cryptocurrency riskier than cash	-0.001	-0.003	0.004	-0.005	0.005	0.001
	[0.003]	[0.004]	[0.004]	[0.010]	[0.012]	[0.013]
- " - bonds	-0.004	0.006	-0.002	0.001	0.010	-0.011
	[0.003]	[0.004]	[0.004]	[0.011]	[0.013]	[0.014]
- " - stocks	0.001	-0.015***	0.015***	-0.015	-0.009	0.024*
	[0.003]	[0.004]	[0.004]	[0.010]	[0.012]	[0.013]
- " - real estate/property funds	0.001	0.006	-0.007	0.029***	-0.015	-0.014
	[0.003]	[0.004]	[0.004]	[0.011]	[0.013]	[0.015]
- " - gold	-0.002	0.010**	-0.008*	0.021*	0.007	-0.029*
	[0.003]	[0.004]	[0.004]	[0.011]	[0.014]	[0.015]
- " - investing in own business	-0.002	-0.003	0.005	-0.019*	0.005	0.014
	[0.003]	[0.004]	[0.004]	[0.011]	[0.012]	[0.014]
Fin. literacy* Cryptocurrency riskier than cash	–	–	–	0.009	-0.018	0.008
				[0.020]	[0.024]	[0.026]
- " - bonds	–	–	–	-0.011	-0.007	0.018
				[0.021]	[0.026]	[0.027]
- " - stocks	–	–	–	0.031	-0.012	-0.019
				[0.021]	[0.024]	[0.026]
- " - real estate/funds	–	–	–	-0.057***	0.044*	0.013
				[0.021]	[0.027]	[0.028]
- " - gold	–	–	–	-0.046**	0.006	0.040
				[0.021]	[0.027]	[0.029]
- " - investing in own business	–	–	–	0.035*	-0.017	-0.018
				[0.020]	[0.024]	[0.026]
%Fin. literacy effect	*-25.5%*	*1.3%*	*4.7%*	*-7.0%*	*-4.3%*	*2.7%*
%Interquartile-change effect	*-40.5%*	*3.4%*	*9.3%*	*-12.3%*	*-7.6%*	*5.0%*
#Observations		9,538			9,538	
Log-likelihood		-6,065.6			-6,048.6	
Wald χ^2		2,340.0***			2,361.9***	

This table reports selected estimates of the determinants of attitudes to cryptocurrencies from two weighted multinomial probit regressions for the sub-sample of individuals who have heard of cryptocurrencies before. Marginal effects and robust standard errors are presented in brackets. The first model (A_1 - A_3) incorporates nice variables capturing reward and risk perceptions on cryptocurrencies among the individuals who have heard of them. The second model (B_1 - B_3) also incorporates nine interaction terms between financial literacy and the risk perceptions on cryptocurrencies. The remaining specification is identical to that of Table 2.

Table 12
The interaction between financial literacy and continuous reward/risk variables

	Own	*Intend to own*	*Not intend to own*	*Own*	*Intend to own*	*Not intend to own*
	(A_1)	(A_2)	(A_3)	(B_1)	(B_2)	(B_3)
Financial literacy	-0.378**	0.054	0.324*	-0.087	-0.129	0.215
	[0.151]	[0.170]	[0.173]	[0.219]	[0.236]	[0.253]
Reward perception	0.466***	0.607***	-1.073***	0.559***	0.482***	-1.040***
	[0.020]	[0.021]	[0.020]	[0.078]	[0.078]	[0.093]
Fin. Literacy*Reward perception	–	–	–	-0.191	0.258*	-0.067
				[0.150]	[0.156]	[0.183]
Risk perception	-0.038**	0.017	0.021	0.077	0.004	-0.081
	[0.018]	[0.021]	[0.022]	[0.060]	[0.067]	[0.076]
Fin. Literacy*Risk perception	–	–	–	-0.231**	0.031	0.200
				[0.113]	[0.130]	[0.142]
Technological literacy	0.078***	0.059***	-0.137***	0.079***	0.058***	-0.137***
	[0.016]	[0.018]	[0.019]	[0.016]	[0.018]	[0.019]
Preference for cash	0.002	-0.002	0.001	0.002	-0.002	0.001
	[0.007]	[0.008]	[0.009]	[0.007]	[0.008]	[0.009]
Inflectional FTR	-0.064**	0.156***	-0.091***	-0.064**	0.155***	-0.091***
	[0.028]	[0.036]	[0.033]	[0.028]	[0.036]	[0.033]
Male	0.066***	0.022**	-0.088***	0.066***	0.021**	-0.087***
	[0.008]	[0.009]	[0.009]	[0.008]	[0.009]	[0.009]
Log(Household income per capita)	-0.001	0.012	-0.011	-0.001	0.013	-0.013
	[0.024]	[0.027]	[0.029]	[0.024]	[0.027]	[0.029]
Log(Household income per capita)^2	-0.001	-0.004	0.005	-0.001	-0.005	0.006
	[0.006]	[0.007]	[0.008]	[0.006]	[0.007]	[0.008]
Log(Household income per capita)^3	0.001	0.001	-0.001	0.001	0.001	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Missing household income p.c.	-0.023	-0.014	0.037	-0.023	-0.014	0.037
	[0.028]	[0.031]	[0.032]	[0.028]	[0.031]	[0.032]
%Fin. literacy effect	*-25.4%*	*1.3%*	*4.7%*	*-6.5%*	*-6.5%*	*3.2%*
%Interquartile-change effect	*-40.3%*	*3.4%*	*9.3%*	*-11.4%*	*-11.3%*	*6.1%*
#Observations		9,538			9,538	
Log-likelihood		-6,098.4			-6,094.5	
Wald χ^2		2,321.9***			2,320.9***	

This table reports selected estimates of the determinants of attitudes to cryptocurrencies from two weighted multinomial probit regressions for the sub-sample of individuals who have heard of cryptocurrencies before. Marginal effects for the three categories of the variable on attitudes to cryptocurrencies are presented in Columns A_1 - A_3 and Columns B_1 - B_3, respectively, along with robust standard errors in brackets. The first model (A_1 - A_3) incorporates two continuous indices capturing the reward perceptions and the risk perceptions regarding cryptocurrencies among the individuals who have heard of them. The second model (B_1 - B_3) also incorporates two interaction terms between financial literacy and the reward and risk perceptions on cryptocurrencies. The remaining specification is identical to that of Table 2.

Table 13
The effect of the constituent concepts of financial-literacy

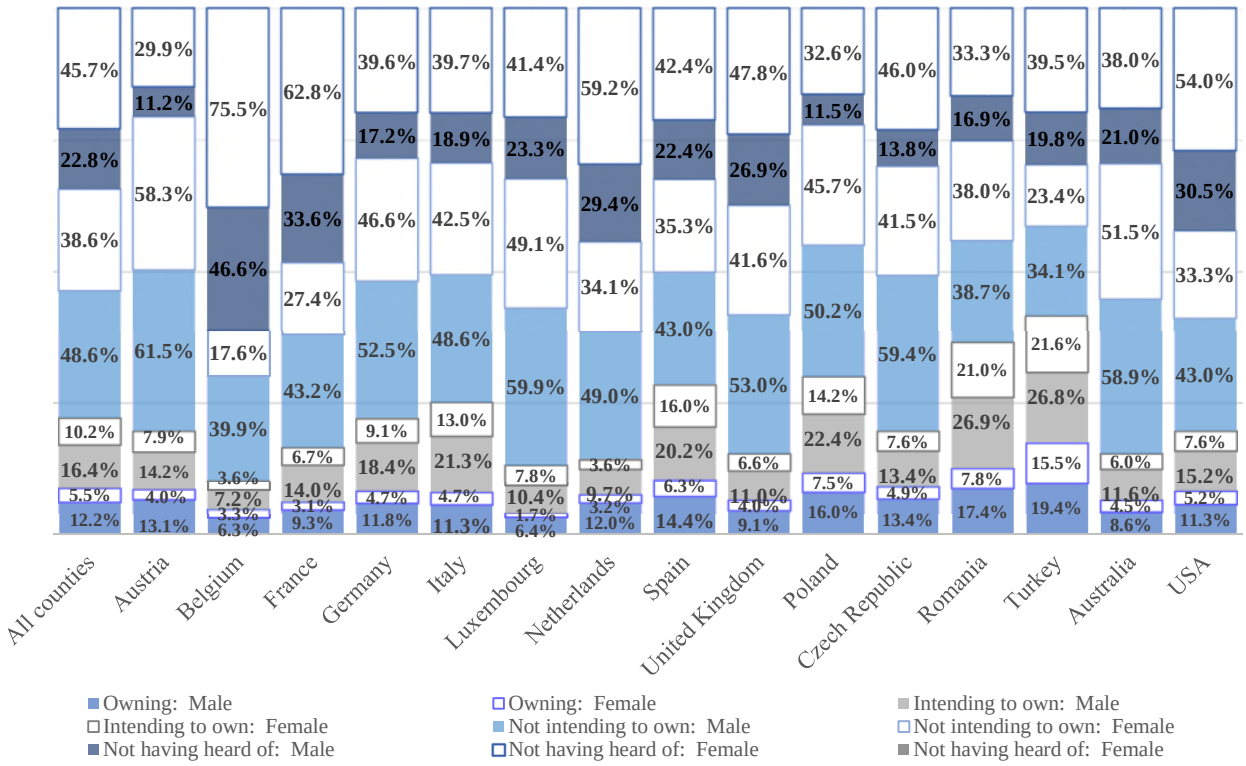
	Own	*Intend to own*	*Not intend to own*	*Not having heard of*
	(1)	(2)	(3)	(4)
Fin. Literacy I: Financial risk	-0.059***	-0.060***	0.056**	0.063**
	[0.016]	[0.019]	[0.028]	[0.026]
Fin. Literacy II: Inflation	-0.003	0.019	-0.256***	0.239***
	[0.014]	[0.018]	[0.027]	[0.026]
Fin. Literacy III: Interest/numeracy	0.012	0.072**	0.445***	-0.528***
	[0.023]	[0.029]	[0.042]	[0.039]
Fin. Literacy IV: Compound interest	0.031**	-0.048***	-0.211***	0.229***
	[0.015]	[0.018]	[0.028]	[0.027]
Technological literacy	0.118***	0.131***	-0.057***	-0.192***
	[0.011]	[0.013]	[0.020]	[0.019]
Inflectional FTR/risk tolerance	-0.002	0.018**	-0.128***	0.112***
	[0.006]	[0.007]	[0.010]	[0.010]
Preference for cash/informality	0.016***	0.018***	-0.032***	-0.003
	[0.005]	[0.006]	[0.008]	[0.008]
Male	0.058***	0.047***	0.087***	-0.192***
	[0.005]	[0.006]	[0.009]	[0.009]
Log(Household income per capita)	0.002	-0.007	-0.035	0.040*
	[0.014]	[0.017]	[0.024]	[0.022]
Log(Household income per capita)^2	-0.001	0.004	0.009	-0.013**
	[0.004]	[0.004]	[0.006]	[0.006]
Log(Household income per capita)^3	0.001	-0.001	-0.001	0.001**
	[0.000]	[0.000]	[0.000]	[0.000]
Missing household income p.c.	-0.043**	-0.024	0.042	0.024
	[0.020]	[0.022]	[0.031]	[0.027]
%Financial risk effect	-6.4%	-4.4%	1.3%	1.8%
%Interquartile-change effect	-18.5%	-12.9%	4.1%	5.8%
#Observations		14,582		
Log-likelihood		-15,983.5		
Wald χ^2		2,850.9***		

This table reports selected estimates of the determinants of attitudes to cryptocurrencies from a weighted multinomial probit regression. Marginal effects for the four categories of the variable on attitudes to cryptocurrencies and robust standard errors are presented in brackets. Instead of a single financial literacy proxy, the specification includes the four financial literacy constituents, i.e. measures that approximate financial knowledge related to financial risk, inflation, interest/numeracy, and compound interest. Except for country dummy variables, which are excluded, the remaining specification is identical to that of Table 2, and it also incorporates 15 interaction terms between financial literacy and country.

Table 14
Interaction between financial literacy and risk tolerance

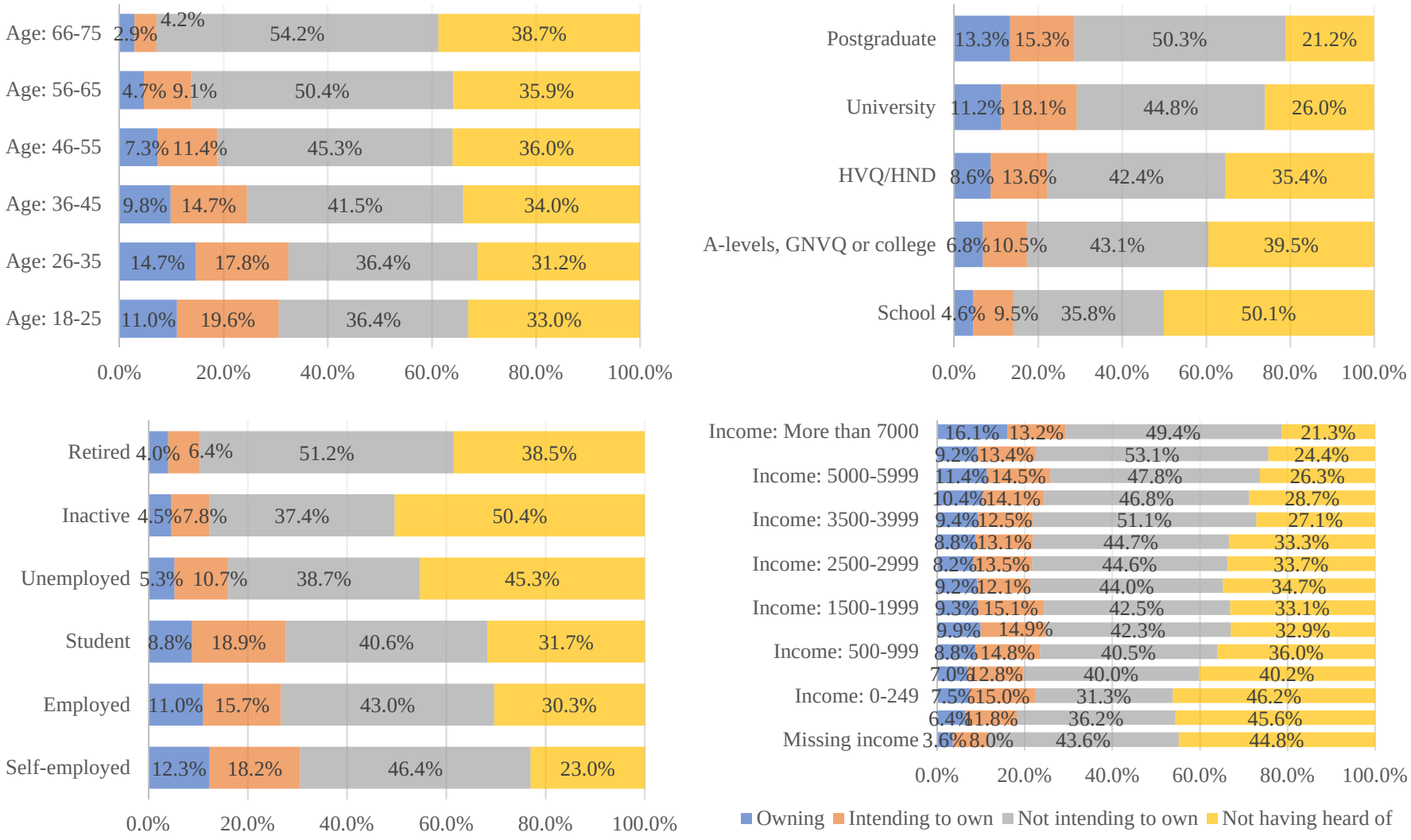
	Own	*Intend to own*	*Not intend to own*	*Not having heard of*
	(1)	(2)	(3)	(4)
Financial literacy	-0.111	0.072	0.552***	-0.513***
	[0.116]	[0.136]	[0.196]	[0.181]
Inflectional FTR/risk tolerance	0.210**	0.195*	-0.312*	-0.093
	[0.097]	[0.110]	[0.164]	[0.151]
Fin. Literacy*Inflectional FTR	-0.386**	-0.124	0.505*	0.004
	[0.170]	[0.193]	[0.292]	[0.269]
Technological literacy	0.113***	0.123***	-0.058***	-0.178***
	[0.011]	[0.013]	[0.020]	[0.018]
Preference for cash/informality	0.012**	0.005	-0.044***	0.027***
	[0.005]	[0.006]	[0.009]	[0.008]
Male	0.062***	0.048***	0.074***	-0.183***
	[0.006]	[0.007]	[0.010]	[0.009]
Log(Household income per capita)	-0.013	-0.014	-0.064**	0.091***
	[0.016]	[0.019]	[0.029]	[0.026]
Log(Household income per capita)^2	0.003	0.005	0.019**	-0.027***
	[0.004]	[0.005]	[0.008]	[0.007]
Log(Household income per capita)^3	-0.001	-0.001	-0.001**	0.002***
	[0.001]	[0.001]	[0.001]	[0.001]
Missing household income per capita	-0.039**	-0.019	0.034	0.024
	[0.020]	[0.022]	[0.031]	[0.027]
%Fin. literacy effect	*-12.7%*	*4.2%*	*12.7%*	*-14.0%*
%Interquartile-change effect	*-21.0%*	*8.6%*	*25.4%*	*-23.2%*
#Observations	14,582			
Log-likelihood	-15,667.4			
Wald χ^2	3,330.5***			

This table reports selected estimates of the determinants of attitudes to cryptocurrencies from a weighted multinomial probit regression. Marginal effects for the four categories of the variable on attitudes to cryptocurrencies and robust standard errors are presented in brackets. The specification includes an interaction term between financial literacy and inflectional FTR, i.e. our risk tolerance proxy. The remaining specification is identical to that of Table 2.



Appendix Figure A1
Attitudes to cryptocurrencies and gender (ING International Survey on Mobile Banking, 2018)

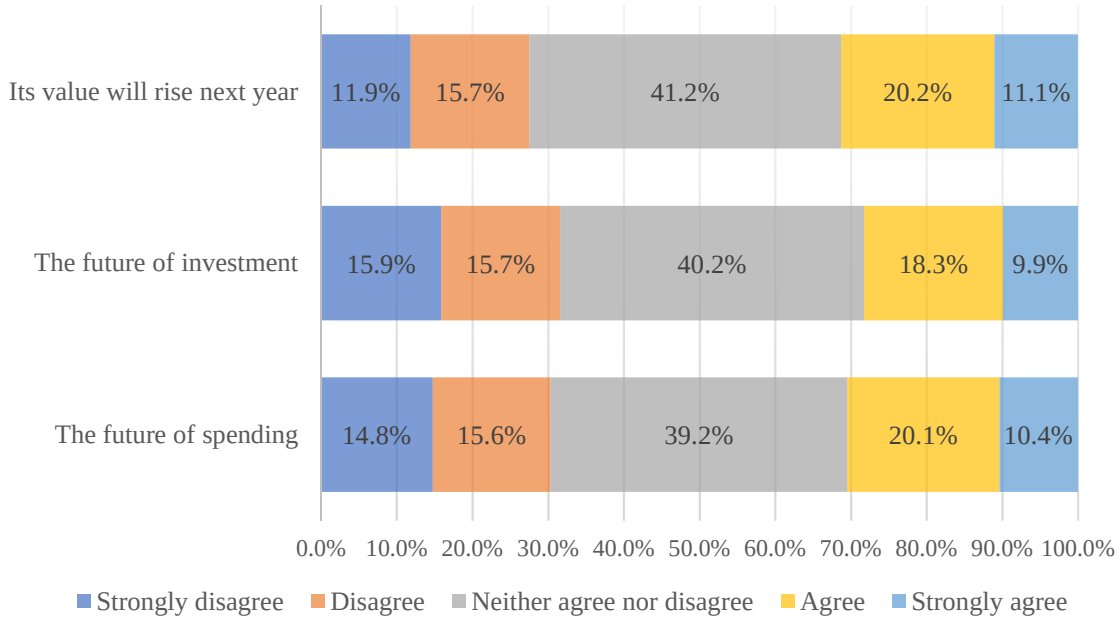
This figure presents the demographic composition of attitudes to cryptocurrencies by gender. Each bar of the figure presents the weighted frequencies of the four categories for each gender, i.e. (i) owning cryptocurrency; (ii) not owning but intending to own; (iii) not owning and not intending to own, and (iv) not having heard of cryptocurrencies before. The first bar shows the frequencies for the sample overall, by gender, and, then, the remaining bars present the frequencies by gender for each of the counties in our sample. Females are presented in white boxes in each bar.

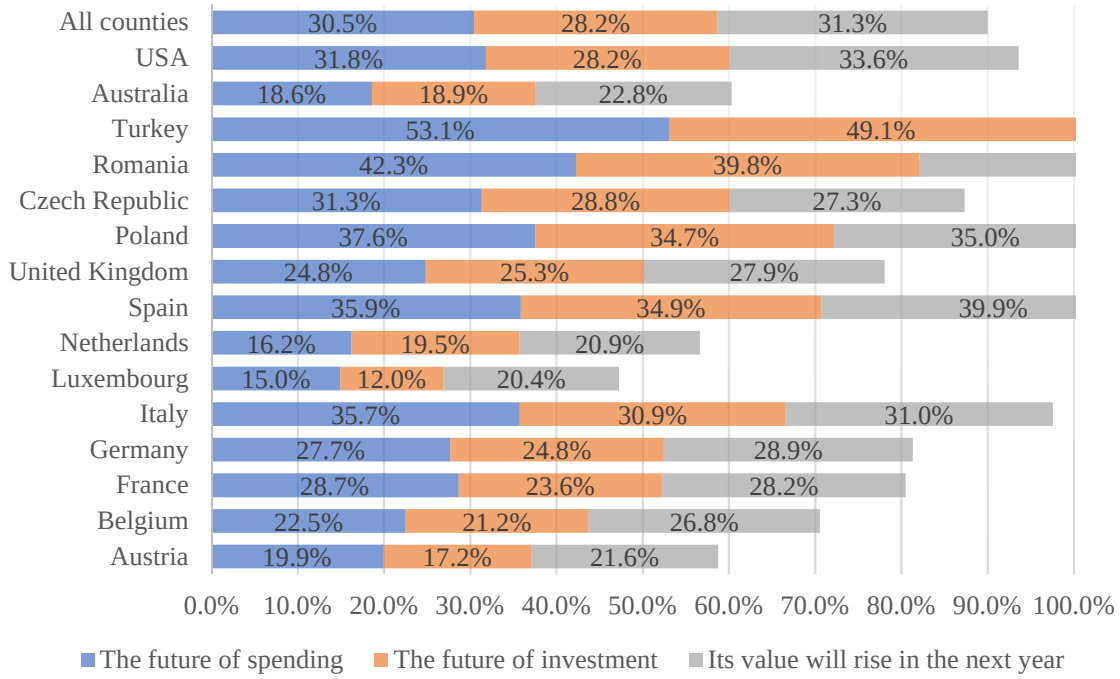


Appendix Figure A2

Attitudes to cryptocurrencies by demographic group (ING International Survey on Mobile Banking 2018)

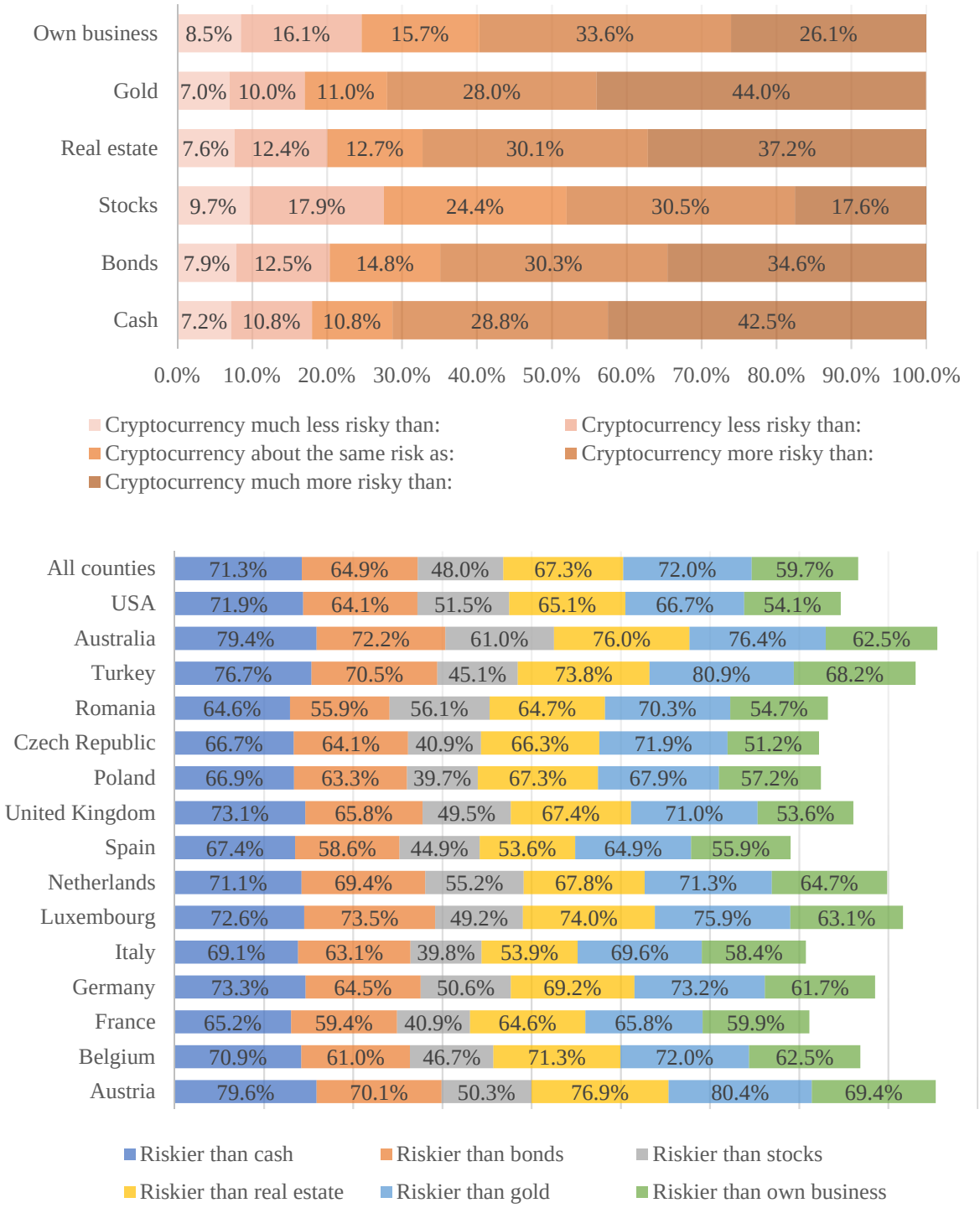
This figure presents the demographic composition of attitudes to cryptocurrencies by age group, education category, labour market status, and income bracket. All figures are weighted.





Appendix Figure A3
Reward perceptions on cryptocurrencies

This figure presents the response frequencies in each of the 3 cryptocurrency reward perception questions. The top figure presents the percentages of individuals who strongly disagree, disagree, neither agree nor disagree, agree, and strongly agree with each of the three statements regarding the prospects of cryptocurrencies, such as the bitcoin. The bottom picture presents the fraction of individuals who agree or strongly agree with each of the three statements in the overall sample, and then for each country in the sample. All figures are weighted.



Appendix Figure A4
Risk perceptions on cryptocurrencies

This figure presents the response frequencies in each of the 6 cryptocurrency risk perception questions. The top figure presents the percentages of individuals who find that cryptocurrency entails much lower risk, lower risk, about the same risk, higher risk, and much higher risk than each of the 6 alternatives, i.e. cash, bonds, stocks, gold, real estate/property funds, investment in own business. The bottom picture presents the fraction of individuals who find that holding cryptocurrency entails higher risk or much higher risk, compared to holding each of the 6 alternatives in the overall sample, and then for each country in the sample. All figures are weighted.

Appendix Table A1
Risk and return characteristics of the bitcoin and other instruments

	3-year period (2016-2018)				1-year period (2018)			
	Return % (ann.)	SD % (ann.)	Sharpe	Sortino	Return % (ann.)	SD % (ann.)	Sharpe	Sortino
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bitcoin	55.79	75.13	0.72	1.40	-79.46	79.50	-1.00	-1.95
Cash	1.01	0.04	-	-	1.89	0.02	-	-
Bonds	2.20	3.18	0.38	1.03	2.02	2.76	0.04	1.12
Equities	17.23	21.00	0.77	1.25	-2.42	23.58	-0.18	-0.02
Gold	5.61	12.39	0.37	0.75	-2.16	9.78	-0.41	-0.25
Real Estate	1.21	10.60	-0.08	0.09	-10.90	10.67	-1.18	-1.28

This table presents calculations of the standard investment risk and return characteristics of the Bitcoin, and other financial instruments, namely cash, bonds, equities, gold, and real estate. The left panel entails calculations for the 3-year period between 1.1.2016 - 1.1.2019, and the right panel presents calculations for the 1-year period between 1.1.2018 – 1.1.2019. Columns 1 and 5 present the annualized return and Columns 2 and 6 present the standard deviation. Columns 3 and 7 present the Sharpe ratio. Columns 4 and 8 present the Sortino ratio. The analysis employs 0.5% as the risk-free rate ($\bar{R}$) for the calculation of the Sharpe and Sortino ratios. The Sharpe ratio is calculated as the excess reward of each asset (j) over the risk-free rate divided by the standard deviation, i.e. $Sharpe_j = \frac{R_j - \bar{R}}{SD_j}$. The Sortino ratios is calculated as the excess reward over the risk-free rate divided by the standard deviation of the downside, i.e. $Sortino_j = \frac{R_j - \bar{R}}{SD_j^D}$.The data stems from Thomson Reuters and Bloomberg. The US T-Bill is used as a cash proxy. The Bloomberg Barclays GDP Core Developed Govt AA- or Above TR Hedged USD are used to display sovereign bonds. The SP GLOBAL total return index is used for Equities. The Gold Bullion LBM $/t, US T-Bill for Gold; The MSCI ACWI REAL ESTATE USD price index is used for real estate. The Bitcoin daily price in stems from Coindesk.

Appendix Table A2
Country-level financial literacy scores

Country	Country score	Constituent concepts			Gender		Age group			Income group	
		Financial risk	Inflation	Interest/ numeracy	Compound interest	Males	Females	15-34	35-54	>55	Top 60%	Bottom 40%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
United States	57%	69%	63%	52%	61%	62%	52%	57%	65%	57%	64%	47%
Australia	64%	69%	63%	61%	68%	72%	56%	64%	67%	72%	73%	50%
Austria	53%	59%	64%	61%	52%	55%	51%	56%	54%	54%	59%	44%
Belgium	55%	65%	62%	58%	53%	59%	52%	63%	58%	56%	59%	50%
France	52%	50%	67%	60%	54%	56%	48%	46%	58%	53%	55%	47%
Germany	66%	74%	62%	66%	64%	72%	60%	72%	82%	61%	73%	55%
Italy	37%	40%	55%	55%	38%	45%	30%	47%	39%	35%	44%	27%
Luxembourg	53%	53%	67%	57%	51%	61%	46%	58%	49%	57%	56%	50%
Netherlands	66%	73%	67%	59%	69%	75%	58%	71%	71%	68%	71%	60%
Spain	49%	56%	65%	59%	43%	50%	48%	47%	51%	56%	54%	43%
United Kingdom	67%	69%	66%	71%	68%	66%	68%	67%	71%	68%	70%	63%
Czech Republic	58%	56%	64%	71%	54%	65%	53%	59%	60%	61%	61%	55%
Poland	42%	39%	63%	60%	45%	49%	36%	50%	44%	39%	44%	40%
Romania	22%	22%	49%	37%	25%	22%	22%	30%	23%	19%	25%	17%
Turkey	24%	23%	47%	49%	45%	28%	19%	28%	23%	16%	26%	20%

This table reports the representative country-level scores in financial literacy, its 4 constituent concepts, and the figures by gender, age group and income group for the selected sample of 15 counties from the S&P 2014 Global Financial Literacy Survey. The figures are publicly available at: https://www.cssf.lu/fileadmin/files/Protection_consommateurs/Education_financiere/SP_Ratings_Global_FinLit-Summary_Statistics_as_of_12152015.xls

Table A3
Weighted summary statistics by financial literacy group

	All	FLH	FLL	Difference [Sig.]	
	(1)	(2)	(3)	(4)	
Financial literacy	0.518	0.545	0.495	0.051	***
Technological literacy	0.471	0.497	0.449	0.047	***
Preference for cash/informality	0.824	0.810	0.836	-0.026	***
Risk tolerance/Inflectional FTR	0.327	0.323	0.330	-0.007	
Household income per capita	1,116.4	1,396.5	886.6	509.876	***
Missing income	10.7%	11.1%	10.3%	0.009	
Male	49.0%	78.6%	24.4%	0.542	***
Age	44.45	43.52	45.23	-1.708	***
Young (<45)	49.7%	53.3%	46.8%	0.066	***
Married	51.0%	52.0%	50.1%	0.019	**
Single	21.4%	23.4%	19.7%	0.037	***
In a relationship	16.4%	16.5%	16.3%	0.003	
Widowed/Divorced/Separated	11.3%	8.1%	14.0%	-0.059	***
Household size	2.63	2.56	2.69	-0.134	***
Pre-sixteen education	11.7%	9.7%	13.4%	-0.038	***
A-levels, GNVQ or college	34.6%	32.3%	36.5%	-0.042	***
Higher vocational education or HND	17.8%	16.8%	18.6%	-0.017	***
University (Bachelors)	21.8%	23.9%	20.1%	0.038	***
Higher university degree	14.1%	17.4%	11.4%	0.059	***
Occupation: Self-Employed	6.1%	6.8%	5.5%	0.013	***
–"– Full-time employee	44.0%	56.1%	33.9%	0.222	***
–"– Part-time employee	11.3%	7.8%	14.2%	-0.064	***
–"– Student	6.5%	6.4%	6.5%	-0.001	
–"– Unemployed	5.9%	3.2%	8.1%	-0.049	***
–"– Inactive	8.8%	4.1%	12.6%	-0.085	***
–"– Retired	17.6%	15.6%	19.2%	-0.037	***
Fin. advice: An independent financial advisor or bank advisor	19.2%	18.7%	19.7%	-0.010	
–"– My friends/family	7.8%	7.8%	7.8%	-0.001	
–"– The internet and specialist websites	26.6%	29.0%	24.0%	0.050	***
–"– An online computer program or algorithm for tailored advice	6.4%	6.7%	6.2%	0.005	
–"– No financial advice	40.0%	37.8%	42.3%	-0.045	***
Reward perception	0.593	0.587	0.600	-0.013	***
Risk perception	0.737	0.749	0.724	0.025	***
Digital currencies – e.g. Bitcoin – are the future of spending online	2.958	2.929	2.988	-0.058	**
- " - investment as storage of value	2.907	2.866	2.950	-0.084	***
I think the value of digital currencies – e.g. Bitcoin – will increase in the next 12 months	3.030	3.006	3.055	-0.050	**
Cryptocurrency riskier than cash	3.886	3.932	3.836	0.096	***
- " - bonds	3.712	3.795	3.623	0.172	***
- " - stocks	3.283	3.350	3.212	0.138	***
- " - real estate/funds	3.767	3.826	3.705	0.121	***
- " - gold	3.919	3.964	3.871	0.093	***
- " - investing in own business	3.527	3.589	3.460	0.129	***
Ignorance of online payment methods	0.291	0.264	0.312	-0.048	***

This table reports weighted averages for all individuals (Column 1). It reports weighted averages for individuals in the high financial literacy group in Column 2 (FLH), and for individuals in the low financial literacy group in Column 3 (FLL). We employ a binary 'High financial literacy' indicator, which stems from the computation of percentiles of financial literacy for each country separately. Individuals are considered to be of 'high financial literacy' (FLH) if the percentile of their financial-literacy score within their country is greater than 50. If it is lower than fifty within country, they are considered to be of 'low financial literacy' (FLL). Column 4 reports mean differences and asterisks for the levels of significance from weighted t-tests between individuals in the high and the low financial literacy group. The asterisks denote the following levels of significance: *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table A4
Weighted pairwise correlation matrix

	(1) Owning crypto	(2) Intending to own	(3) Financial literacy	(4) Male	(6) Age	(7) University	(8) Entrepreneur	(9) Household income	(10) Inflectional FTR	(11) Tech. literacy	(12) Preference for cash	(13) Risk perception	(14) Reward perception	(15) Future of spending online	(16) –"– investment/stor. value	(17) Value ↑in 12 months	(18) Bitcoin riskier than cash	(19) –"– bonds	(20) –"– equities	(21) –"– real estate	(22) –"– gold	(23) –"– own firm
(1) Owning crypto	1.00																					
(2) Intending to own	-0.12*	1.00																				
(3) Financial literacy	-0.06*	-0.13*	1.00																			
(4) Male	0.11*	0.09*	0.11*	1.00																		
(6) Age	-0.12*	-0.14*	0.09*	-0.02	1.00																	
(7) University	0.04*	0.07*	-0.22*	0.00	-0.06*	1.00																
(8) Entrepreneur	0.10*	0.08*	0.01	0.10*	-0.24*	0.09*	1.00															
(9) Household income	-0.01	-0.05*	0.37*	0.08*	0.19*	0.01	0.09*	1.00														
(10) Inflectional FTR	0.02	0.06*	-0.41*	0.01	-0.03*	0.16*	-0.01	0.02*	1.00													
(11) Technological literacy	0.15*	0.12*	-0.02*	0.08*	-0.16*	0.09*	0.20*	0.06*	0.01	1.00												
(12) Preference for cash	0.04*	0.06*	-0.23*	0.02*	-0.09*	0.01	0.01	-0.18*	-0.02*	0.00	1.00											
(13) Risk perception	-0.15*	-0.12*	0.04*	0.04*	0.17*	0.02*	-0.02*	0.09*	-0.04*	-0.05*	-0.05*	1.00										
(14) Reward perception	0.35*	0.36*	-0.21*	-0.03*	-0.25*	0.05*	0.09*	-0.17*	0.10*	0.15*	0.12*	-0.36*	1.00									
(15) Future of spending online	0.32*	0.34*	-0.21*	-0.02*	-0.23*	0.05*	0.09*	-0.18*	0.09*	0.14*	0.12*	-0.33*	0.92*	1.00								
(16) –"– investment/stor. value	0.32*	0.34*	-0.19*	-0.03*	-0.24*	0.05*	0.09*	-0.17*	0.08*	0.14*	0.11*	-0.35*	0.92*	0.82*	1.00							
(17) Value ↑in 12 months	0.31*	0.29*	-0.17*	-0.02	-0.20*	0.05*	0.07*	-0.11*	0.09*	0.11*	0.10*	-0.30*	0.87*	0.68*	0.70*	1.00						
(18) Bitcoin riskier than cash	-0.12*	-0.09*	0.04*	0.02	0.09*	0.01	-0.04*	0.06*	-0.02	-0.05*	-0.02	0.78*	-0.27*	-0.25*	-0.26*	-0.22*	1.00					
(19) –"– bonds	-0.12*	-0.09*	0.05*	0.06*	0.17*	0.03*	-0.02*	0.08*	-0.03*	-0.04*	-0.07*	0.80*	-0.29*	-0.26*	-0.28*	-0.24*	0.56*	1.00				
(20) –"– equities	-0.12*	-0.13*	0.05*	0.03*	0.14*	0.01	-0.01	0.09*	-0.08*	-0.02*	-0.05*	0.72*	-0.31*	-0.28*	-0.30*	-0.26*	0.44**	0.52*	1.00			
(21) –"– real estate	-0.11*	-0.09*	0.04*	0.02*	0.13*	0.02*	-0.02	0.06*	-0.07*	-0.04*	-0.05*	0.82*	-0.28*	-0.26*	-0.27*	-0.23*	0.56**	0.60*	0.52*	1.00		
(22) –"– gold	-0.11*	-0.06*	0.01	0.02	0.13*	0.02	-0.02	0.04*	-0.02	-0.05*	-0.03*	0.80*	-0.25*	-0.23*	-0.25*	-0.21*	0.60*	0.59*	0.44*	0.62*	1.00	
(23) –"– own firm	-0.11*	-0.10*	0.01	0.03*	0.13*	0.01	-0.01	0.08*	0.01	-0.03*	-0.03*	0.77*	-0.28*	-0.26*	-0.27*	-0.23*	0.51*	0.52*	0.51*	0.55*	0.52*	1.00

This table reports the weighted pairwise correlation matrix for all individuals in the ING 2018 International Survey on Mobile Banking. The asterisk denotes the following level of significance: * p<0.05. The financial literacy variable is calculated as a individual average of the country financial literacy scores by gender, age group (15-34, 35-54, >55) and income (top 60%, bottom 40%) from the S&P 2014 Global Financial Literacy Survey.

Appendix Table A5
The interaction between financial literacy, years of education and income

	Own	*Intend to own*	*Not intend to own*	*Not having heard of*
	($\underline{A}_1$)	($\underline{A}_2$)	($\underline{A}_3$)	($\underline{A}_4$)
Financial literacy	-0.181*	0.035	0.898***	-0.753***
	[0.103]	[0.120]	[0.172]	[0.157]
Years of Education	0.006***	0.003*	0.017***	-0.026***
	[0.001]	[0.002]	[0.002]	[0.002]
Log(Household income per capita)	0.011***	0.007*	0.005	-0.022***
	[0.003]	[0.003]	[0.005]	[0.005]
Fin. literacy*Years of education*Log(Household income p.c.)	-0.001	-0.001	0.001	0.001**
	[0.000]	[0.000]	[0.001]	[0.001]
Technological literacy	0.113***	0.123***	-0.055***	-0.182***
	[0.011]	[0.013]	[0.020]	[0.018]
Preference for cash	0.012**	0.005	-0.045***	0.029***
	[0.005]	[0.006]	[0.009]	[0.008]
Inflectional FTR	-0.007	0.128***	-0.030	-0.091***
	[0.018]	[0.023]	[0.027]	[0.023]
Male	0.062***	0.048***	0.069***	-0.179***
	[0.006]	[0.007]	[0.010]	[0.008]
%Fin. literacy effect	*-20.0%*	*-0.2%*	*20.4%*	*-19.8%*
%Interquartile-change effect	*-31.6%*	*1.6%*	*43.2%*	*-31.4%*
#Observations	14,582			
Log-likelihood	-15,687.7			
Wald χ^2	3,305.1***			

This table reports selected estimates of the determinants of attitudes to cryptocurrencies from a weighted multinomial probit regression. Marginal effects for the four categories of the variable on attitudes to cryptocurrencies and robust standard errors are presented in brackets. The remaining specification is identical to that of Table 2, except for the exception of the 3rd order polynomial in household income and the replacement of the 5 education categories with a continuous variable capturing years of education. The continuous years of education variable is computed as follows: Individuals with 'Pre-sixteen education' get assigned with 9 years of education. Individuals with 'A-levels, GNVQ or college' get assigned with 12 years of education. Respondents with 'Higher vocational education or HND' get assigned with 14 years. Then, respondents with 'University (Bachelor)' get assigned with 16 years, and individuals with 'Higher university degree' get assigned with 19 years. Finally, the specification also incorporates a triple interaction term between financial literacy, years of education, and the logarithm of monthly PPP-divided household income per capita.

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