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Environmental and Social Preferences and Investments in Crypto-Assets

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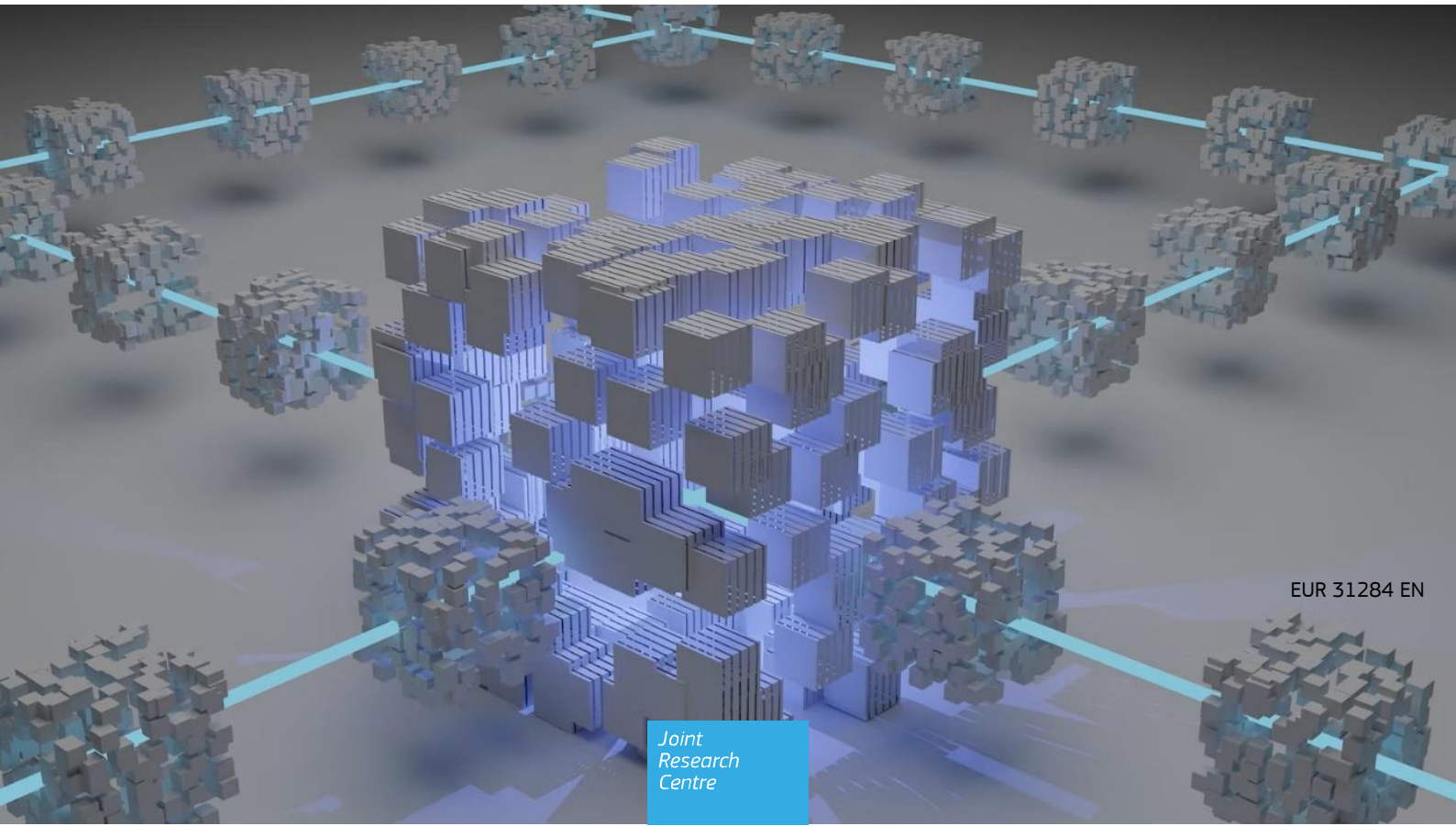

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Contents

Abstract

Individuals invest in Environmental-Social-Governance (ESG)-assets not only because of (higher) expected returns but also driven by ethical and social considerations. Less is known about ESG-conscious investor subjective beliefs about crypto-assets and how these compare to traditional assets. Controversies surrounding the ESG footprint of certain crypto-asset classes – mainly on grounds of their energy-intensive crypto mining – offer a potentially informative object of inquiry. Leveraging a unique representative household finance survey for the Austrian population, we examine whether investors' environmental and social preferences can explain cross-sectional differences in individual portfolio exposure to crypto-assets. We find a strong association between investors' environmental and social preferences and the crypto-investment exposure but no significant relationship for the benchmarks of traditional asset classes such as bonds and shares.

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Executive summary

While household asset portfolios are mostly dominated by real estate and to a lesser extent by financial instruments such as shares, pension funds, or bonds, it appears that non-standard financial instruments, such as crypto-assets have become an increasingly popular investment vehicle, even among small retail investors.

A block-chain, which represents the underlying technology of crypto-assets, contains a large amount of information in a digital format and makes it available to researchers in adjacent real time. However, the block-chain provides a limited view on the socio-economic and demographic characteristics of crypto-asset owners, because in most cases the owners of crypto assets are not known. Hence, previous empirical research on crypto-assets owners typically uses representative survey data to get a better understanding of what determines household demand for crypto-assets (e.g., Fujiki, 2021; Stix, 2021). Generally, younger individuals / households who are more educated, financially literate, self-confident, risk-loving (males) tend to hold crypto-assets more frequently.

However, recent theoretical (e.g., Ahmed et al., 2021; Pastor et al., 2021b) and empirical (e.g., Anderson and Robinson, 2021) literature stresses the fact, that investors invest not only because of (higher) expected returns of assets, but also due the non-pecuniary considerations, such as environmental and ethical.

Controversies surrounding the environmental footprint of certain crypto-asset classes and illegal activities (e.g., Krause and Tolaymat, 2018; Foley et al., 2019), but also growth of sustainable and inclusive cryptocurrencies (Chapron, 2017) offer a potentially informative object of inquiry on uncovering information about the perceived ESG footprint of crypto-assets by retail investors.

We use unique data on individual finances from the Austrian Survey of Financial Literacy (ASFL) for the year 2019 - the Austrian contribution to the OECD/INFE (International Network for Financial Education) survey on the financial literacy of adults. Generally, OECD/INFE contains questions about financial knowledge, attitudes, and behaviours that the OECD uses to calcu-

late the respective financial literacy scores and various other indicators (OECD, 2018). The ASFL survey was conducted with 1,418 respondents through computer-assisted personal interviews (CAPIs) between April and May 2019. After verifying individual responses and cleaning the data, the final working sample consists of 1,016 individual-level observations.

In our study we estimate the relationship between stated investors' environmental ans social (E&S) preferences and the probability that individuals hold crypto-assets (non-pecuniary effect hypothesis), which we compare to traditional financial asset holdings. In particular, we estimate a linear probability model and probit separately for each of the three asset classes (crypto-assets, bonds, shares) using the ASFL data. In addition to our main explanatory variables of interest, we can control for a large set of variables that have been identified in the previous research as important drivers of individual financial choices such as financial literacy, self-confidence, risk aversion, income, age, education, gender, etc. To reduce the bias due to possible endogeneity of E&S preferences, we employ a version of 2SLS instrumental variables framework proposed by Lewbel (2012).

Our results show that around 3% of the Austrian adult population holds crypto-assets. Results on the determinants of crypto-assets are conventional: individuals with higher levels of financial literacy, higher self-confidence and higher risk tolerance are more likely to participate in cryptocurrency markets. A new discovery is the significance of non-pecuniary factors, especially environmental and social preferences for the financial behaviour of small investors. We found that E&S preferences could explain the different nature of individuals' investment in crypto assets, whereas additionally considering the influence of investors' relevant individual characteristics. We also compare our results with the estimates on the effects of E&S preferences on other types of financial assets (e.g., stocks and bonds). For all considered assets (i.e., cryptos, stocks and bonds) we do not account to what extent they are either green (in other words sustainable) or socially responsible.

Our results suggest that, on average, individuals with stronger E&S preferences tend to invest in crypto assets more frequently, rather than investors who show lower E&S engagement.

On the other hand, E&S preferences do not provide any informational value for investing in stocks or bonds. In the context of crypto-assets' possible use for illegal activities, or their negative environmental impacts due to deployed energy-intensive crypto mining (Proof-of-Work consensus mechanism), the connection of E&S preferences with a higher probability of holding crypto assets may seem surprising.

Previous literature on individuals' ESG attitudes and financial portfolio choices could provide some explanation. For example, corresponded socially "desirable" preferences do not always coincide with household/individual preferences when choosing an investment portfolio (e.g., Anderson and Robinson, 2021). On the supply side, this result could be explained by the growing development of the Proof-of-Stake crypto-asset consensus mechanism, which is explicitly designed to be more energy efficient and have a minimal impact on the environment, while still generating consensus within blockchains protocols (see Saleh, 2021).

With these findings, we contribute to expanding the knowledge about the connection between revealed E&S preferences and holding financial assets. Perceived "E&S footprint" is clearly an important factor in crypto-asset investment decisions made by retail investors. Furthermore, our results point to the need of increasing the collection of information on crypto assets, for example in common household finance surveys.

This area requires further research using larger data sets on household finances, so that a more thorough socio-economic (causal) analysis of the relationship between ESG preferences and investing in various financial instruments, including other non-traditional financial market products, could be made. For this reason, we consider that, it is necessary to consistently include questions about crypto-assets in regular surveys about household finances. Data from representative surveys (which include extensive information on crypto-asset holdings along with the rest of household assets), as well as a wide variety of socio-economic characteristics and preferences can provide a deeper understanding of household portfolio choices. The knowledge based on micro-data could also be valuable for observing the financial behaviour of households and the emergence of possible risks for financial stability.

1 Introduction

In a standard asset pricing framework, financial decisions are determined by investor's preferences and beliefs over asset returns. A more recent literature has identified also the relevance of investor environment and non-pecuniary effects in driving cross-sectional differences in investment decision (Chen et al., 2020; Jiang et al., 2021). Accordingly, an investor weighs between optimising a standard mean-variance utility[1] and maintaining a "target portfolio". The mean-variance utility captures the pecuniary effect of standard mean-variance preferences; investors' characteristics and personality differences affect investment decisions through these channels of beliefs and risk preferences. The target portfolio, in a reduced form, reflects non-pecuniary effects, such as the social and ethical/moral concerns.

The focus of the present paper is on non-pecuniary effects related to environmental and social (E&S)[2] preferences in retail investor portfolio exposure to various financial assets, including crypto-assets.[3] Controversies surrounding the ESG footprint of certain crypto-asset classes – mainly on grounds of their energy-intensive crypto mining – offer a potentially informative object of inquiry.

Very little is known about E&S-conscious investor subjective beliefs about crypto-assets and how do these compare to traditional assets in the portfolio formation. We aim to answer the question to what extent can environmental and social/ethical considerations explain cross-sectional differences in crypto-asset investments after controlling for investor individual characteristics and demographic variables. To benchmark our results, we compare how investors' E&S preferences relate to portfolio exposure to crypto-assets on the one side and "E&S-blind" traditional financial assets, such as bonds and shares,[4] on the other side.

The fact that crypto-assets are decentralized and rather anonymous compared to other cen-

[1] The mean-variance utility assumes that random variables with the same mean and variance have equal desirability.

[2] Through the paper we use term "E&S" since we can observe and measure only the environmental (E) and social (S) attitudes of individuals.

[3] This report is based on results and analyses of Ciaian et al. (2022a,b).

[4] Unlike the Swedish household survey utilised by Anderson and Robinson (2021), our survey questions do not identify separately E&S bonds/stocks and non-E&S assets.

tralized financial products is both, a blessing and a curse for research. The block-chain – a back bone of crypto-assets – contains a wealth of information in digital format and makes them near-real time accessible for researchers. However, one can only get very limited insight from a block-chain about who actually holds these assets. Therefore it is convenient to employ survey data to learn more about this new item in the portfolio of private households.

This is the first paper that investigates if and to what extent E&S preferences drive individual portfolio exposure to crypto-assets by leveraging representative individual-level portfolio data. The Austrian Survey of Financial Literacy (ASFL) data are unique in the sense that most of standard household finance surveys do not include crypto-asset holdings as separate items. The ASFL data allow us to distinguish between individuals' investment choices between crypto-assets, bonds and shares. A common empirical challenge when estimating the effect of preferences on portfolio composition is the potential endogeneity of investors' E&S preferences in our context. We take a number of steps in response to endogeneity concerns including an IV estimator. To deal with potential endogeneity in the absence of instruments for a standard IV approach, we employ an alternative identification strategy proposed by Lewbel (2012)[5]. It exploits variation on higher moment conditions of the error distribution from the first stage regression of the likely endogenous covariate on (a subset of) other covariates in the model.

There are two strands of literature our work is related to. First, the household finance and asset pricing contributions in the sustainable and responsible investing (SRI) literature have examined the unconditional and conditional ESG stock return performance. The empirical literature has established that ESG assets might outperform non-ESG assets when positive shocks hit the ESG factor, which captures for example shifts in consumers' tastes for green products and investors' tastes for green holdings (e.g., Pastor et al., 2021a). The explosive growth in responsible investing has given rise to a growing theoretical asset pricing literature that relies on non-pecuniary utility functions (e.g., Ahmed et al., 2021; Pastor et al., 2021b; Liu and Peifer, 2022).

[5]The use of this estimation technique is increasingly popular in the household finance literature (e.g., Bannier and Schwarz, 2018; Deuflhard et al., 2019). Practical application of this estimation procedure is detailed in Baum and Lewbel (2019).

The conceptual explanation for the incorporation of ESG preferences into investment decision-making relies on the idea that social preferences can affect investment decisions because they serve as a proxy for value-relevant information or risk, they enhance performance or reduce risk (Krueger et al., 2020). Empirically the link between ESG preferences and portfolio choice is not that clear. Anderson and Robinson (2021) find no relationship between ESG attitudes and pro-environmental portfolios. Even less is known about non-pecuniary utility and its relation to crypto-assets. How do E&S-conscious investors value crypto-assets, and do sustainable crypto investment products offer superior risk-adjusted returns? Our study contributes to a better understanding of non-pecuniary effects in individual investment decisions by assessing the role of an E&S-driven motivation in individual crypto investment decisions and benchmarking results against traditional asset holdings.

Second, a rich crypto-asset literature estimates the realised ESG footprint of crypto-assets (e.g., Krause and Tolaymat, 2018; Barone and Masciandaro, 2019; Foley et al., 2019; Kohler and Pizzol, 2019; Richman et al., 2021; Teichmann and Falker, 2021; Parmentola et al., 2022) or how pecuniary effects explain individuals' investment demand for crypto-assets (Bouri et al., 2019; Xi et al., 2020). On the one hand, this literature suggests that crypto-assets have the potential to generate a variety of social and governance benefits either directly via a decentralised governance mechanism or via the way crypto-assets and the underlying blockchain technology are deployed (e.g., Ciaian et al., 2016; Chapron, 2017; Richman et al., 2021). On the other hand, crypto-assets are sometimes associated with undesirable social activities, such as illicit trade, money laundering and tax evasion (e.g., Barone and Masciandaro, 2019; Foley et al., 2019; Teichmann and Falker, 2021). Further, due to a continuously growing energy consumption to maintain the underlying blockchain network, certain crypto-assets are associated with negative environmental impacts. Particularly the Proof-of-Work (PoW) consensus mechanism of Bitcoin consumes large amounts of energy generating negative environmental externalities (e.g., Krause and Tolaymat, 2018; Dilek and Furuncu, 2019; Kohler and Pizzol, 2019).

Overall, the literature findings of the relationship between social, environmental and gov-

ernance aspects of crypto-assets on individual portfolio exposure to crypto holdings is largely inconclusive; it depends among others on the specific crypto-asset and individual perceptions of investors. Our main finding that stronger E&S preferences go along with higher probability to hold crypto-assets might seem somewhat surprising at first sight, however, it conceivably ties in with previous literature on ESG attitudes and financial portfolio choice finding that socially "desirable" preferences communicated do not always match the preferences revealed from portfolio choice (see Anderson and Robinson, 2021).

The present study contributes to enhancing our knowledge about the interplay between stated preferences, revealed E&S beliefs and portfolio holdings by providing novel insights about the relationship between environmental and social preferences and individual portfolio exposure to crypto-assets. Indirectly it therefore also conveys information about the perceived E&S footprint of crypto-assets by retail investors. Furthermore, it illustrates the value added of augmenting the information on crypto-assets in standard household finance surveys for enhancing our understanding about crypto-asset holdings and investment decisions within a general portfolio choice context and along with socio-economic information.

The paper proceeds as usual. Data and variables are described in section 2 and section 3 presents the implemented empirical framework and strategies. Results of the multivariate analysis, along with several robustness checks, are presented and discussed in section 4. Finally, section 5 concludes and offers policy implications.

2 Data and variables

2.1 Austrian Survey of Financial Literacy

We leverage a unique individual portfolio data from the Austrian Survey of Financial Literacy (ASFL) for 2019 – the Austrian contribution to the OECD/INFE (International Network for Financial Education) survey on adult financial literacy. The standard OECD/INFE survey comprises questions on financial knowledge, attitudes and behaviour, used by the OECD to calculate the

respective financial literacy scores, as well as several control variables and demographics (see OECD, 2018). The ASFL survey was conducted with 1,418 respondents through computer-assisted personal interviews (CAPIs) between April and May 2019. After verifying individual responses and cleaning the data, the final working sample consists of 1,016 individual-level observations. The main descriptive results of the ASFL as well as methodological details are reported in Fessler et al. (2020). First results on crypto-assets owners in Austria are reported in Stix (2021).

The description of variables used in empirical estimations is provided in Table A.1 of the Appendix. Our main dependent variable measures whether an individual owns crypto-assets (*Crypto-assets ownership*). To compare how investors' behaviour differs between crypto-assets and traditional financial assets, we construct two further dependent variables capturing individuals' ownership of bonds (*Bonds ownership*) and shares (*Stocks/shares ownership*).[6]

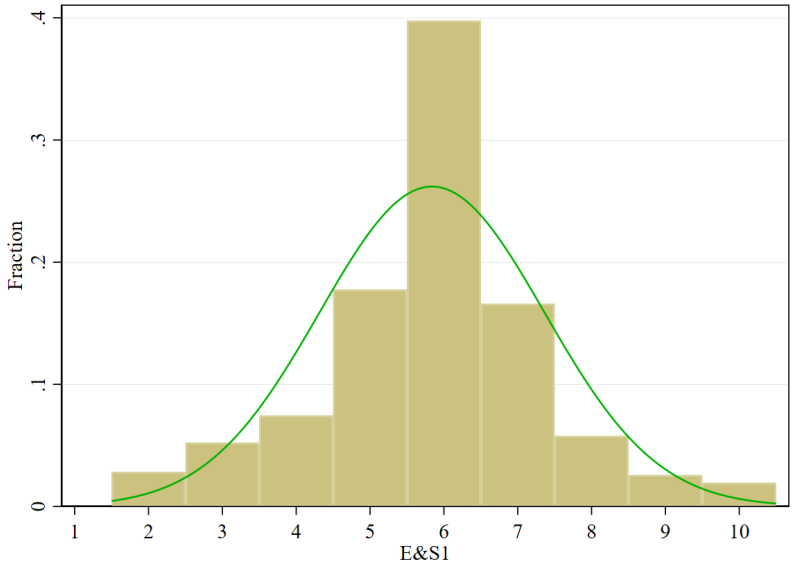
The explanatory variables of particular interest are those capturing environmental and social preferences of retail investors. We consider one variable proxying environmental attitudes, *Preferences for enviro. issues (E)*, and two alternative variables capturing social attitudes, *Preferences for social issues (S1)* and *Preferences for social issues (S2)*, respectively. All three environmental and social preference variables take values between 1 to 5 with a higher value indicating stronger attitude. We also construct composite E&S indicators that measure combined environmental and social attitudes of surveyed individuals. The composite E&S indicators are constructed by summing up the values of environmental and social attitude variables: i.e. *E&S1* is calculated as the sum of *E* and *S1* and *E&S2* as the sum of *E* and *S2*. Distributions of the computed E&S scores are shown in Figure 1.

Following previous studies on individual investors' portfolio composition and returns and risky financial behaviour (e.g., Duarte et al., 2021; Ehrlich and Yin, 2022), we include a number of control variables to account for individual characterises such as age, gender, education (*Primary education*, *Secondary education*, *Tertiary education*) and income (*Individual monthly net*

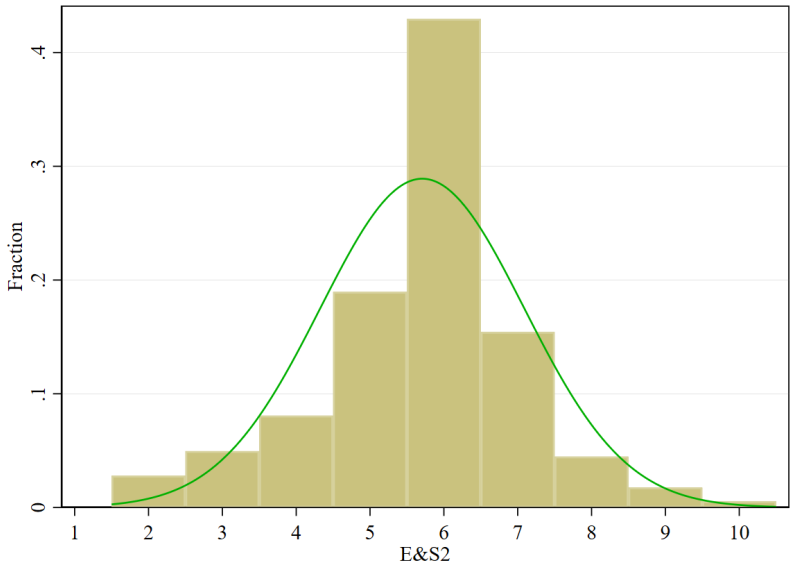
[6] In the empirical analysis we focus only on the participation decision of household investments, and not the amounts invested in the particular asset class – a common data limitation problem in the empirical household/personal finance literature using observational survey data (e.g., Cupák et al., 2021; Ehrlich and Yin, 2022).

Figure 1: Distribution of E&S preferences

(a) E&S1 score



(b) E&S2 score



Note: This graph shows the distribution of two E&S scores overlaid by the normal density curve (green solid line).
Source: ASFL 2019

income). An important driver of investment decisions of individuals identified in the literature is their objective financial literacy as well as their self-assessment of their own financial knowledge (see Lusardi and Mitchell, 2014; Bannier and Schwarz, 2018; Bannier et al., 2019; Cupák et al., 2019). Two alternative explanatory variables describe financial literacy: the objectively measured financial literacy (*Objective fin. literacy*) and the self-reported financial literacy (*Confidence in own fin. knowledge*). In an attempt to control for risk attitudes of surveyed responders, which were identified in the literature to affect investment decisions (Bekhtiar et al., 2019; Jiang et al., 2021), we also include a variable capturing self-reported willingness to take investment risk (*Risk attitude score*).

2.2 Descriptive statistics

Table 1 reports descriptive statistics of surveyed individuals. Overall, around 3% of Austrian individuals report holding crypto-assets[7], while the share of individuals owning bonds or shares is 7% and 11%, respectively[8]. The average score for environmental preferences (3.7) exceeds the social preferences scores (2.2 and 2.0, respectively) suggesting that the Austrian population might find environmental issues related to finance more important than social ones.[9] Both the objective and subjective financial literacy scores (average values of 5.3 and 3.3, respectively) place Austria to a group of OECD countries with a high financial awareness (see OECD, 2018, for international comparison). Summary statistics of other relevant variables used in the empirical analyses are detailed in Table 1.

[7] This estimated ownership rate is in line with external statistics on crypto-assets holding (see Figure A.1, Appendix).

[8] Note, that while there is some overlap between bonds and shares owners, it is far from perfect. About 62% of those holding bonds hold also shares and about 40% of those holding shares hold also bonds.

[9] Note that while $S1$ relates to ethics with regard to experienced choices of financial agents, $S2$ relates more generally to an assessment of one own's weight placed on ethics in financial decisions. That is why the first measure contains more missing values than the latter as not all individuals experience (regular) choices of financial agents (see Table 1).

Table 1: Descriptive statistics

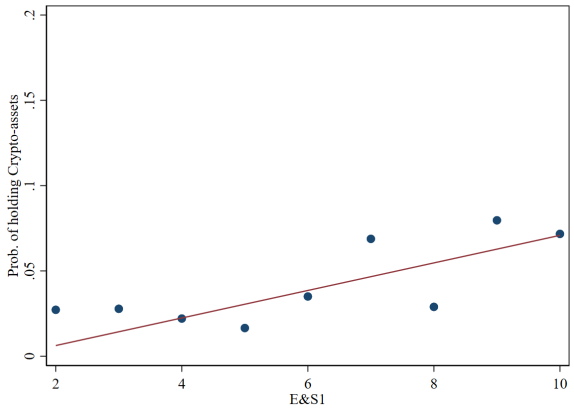
Variable	N	Mean	SD	Min	Max
Crypto-assets ownership	1,402	0.03	0.18	0	1
Bonds ownership	1,398	0.07	0.25	0	1
Stocks/shares ownership	1,404	0.11	0.31	0	1
Preferences for enviro. issues (E)	1,274	3.72	1.15	1	5
Preferences for social issues (S1)	1,198	2.18	1.01	1	5
Preferences for social issues (S2)	1,363	2.03	0.97	1	5
E&S1 (E + S1)	1,126	5.83	1.52	2	10
E&S2 (E + S2)	1,250	5.75	1.42	2	10
Objective fin. literacy	1,418	5.32	1.64	0	7
Confidence in own fin. knowledge	1,382	3.27	0.98	1	5
Risk attitude score	1,418	1.57	0.82	1	4
Primary education	1,382	0.14	0.35	0	1
Secondary education	1,382	0.76	0.43	0	1
Tertiary education	1,382	0.10	0.30	0	1
Individual monthly net income	1,188	1,642.25	812.35	0	5,100
Gender: female	1,418	0.52	0.50	0	1
Age	1,418	49.08	18.20	16	97

Note: Summary statistics computed using survey weights. There are three main regions (Region of East Austria, Region of South Austria, and Region of West Austria), which are equally represented in the survey.
Source: ASFL 2019

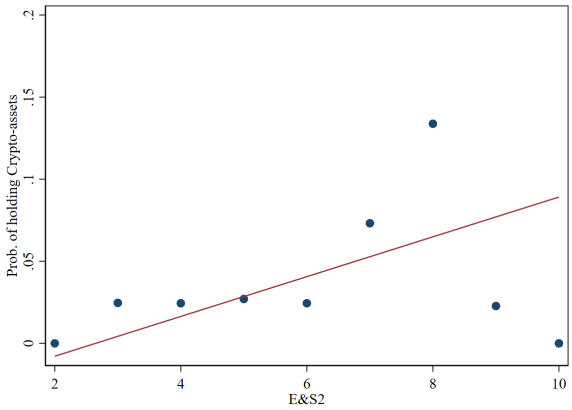
To gain further insights about the underlying ASFL data, we correlate the computed E&S1 and E&S2 scores with the probability of holding various financial assets: crypto-assets, bonds and shares by means of binned scatter plots (Figure 2). A nuanced and somewhat unexpected pattern emerges: while we observe no relationship between environmental and social attitudes and the probability to own bonds or shares, the relationship is positive and statistically significant for crypto-assets.

Figure 2: Correlation between E&S preferences and holdings of different assets

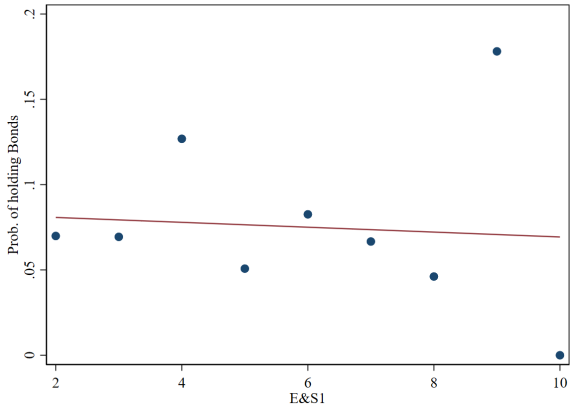
(a) Pr. of holding crypto-assets and E&S1 score



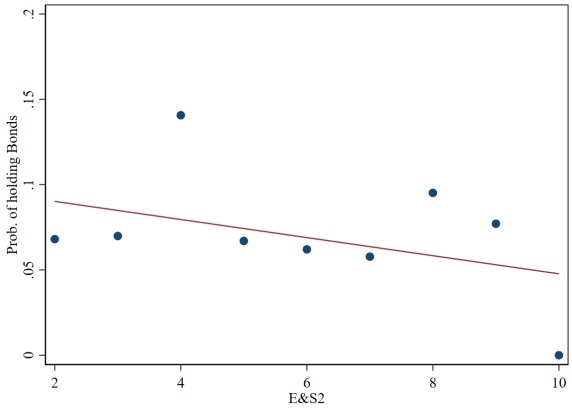
(b) Pr. of holding crypto-assets and E&S2 score



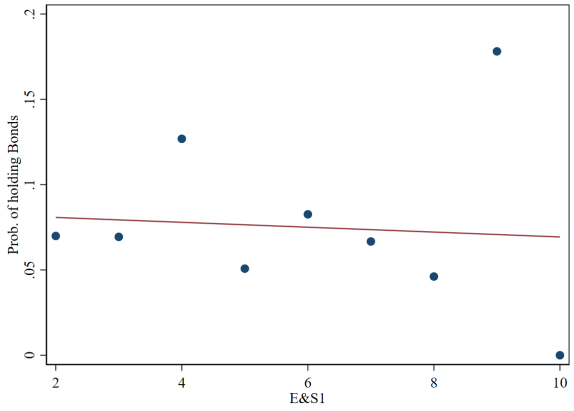
(c) Pr. of holding bonds and E&S1 score



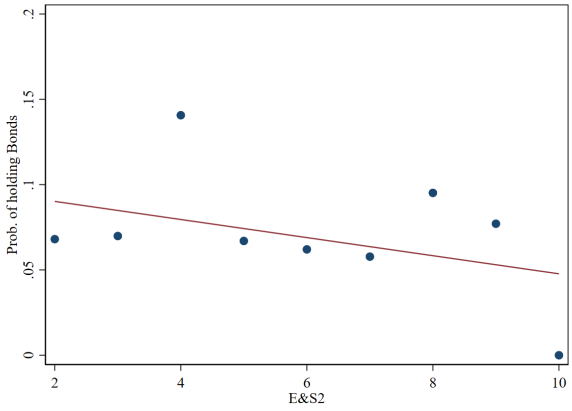
(d) Pr. of holding bonds and E&S2 score



(e) Pr. of holding shares and E&S1 score



(f) Pr. of holding shares and E&S2 score



Note: This graph shows binned scatter plots (i.e. reduced form scatter plot) of E&S preferences and holdings of different assets. The probability to hold a certain asset is shown on the vertical axis, while the E&S scores are shown on the horizontal axis.
Source: ASFL 2019

3 Estimation approach

Our objective is to estimate the relationship between stated investors' E&S preferences and the probability that individuals hold crypto-assets (non-pecuniary effect hypothesis), which we compare to traditional financial asset holdings. In particular, we estimate a linear probability model (LPM) by means of OLS separately for each of the three asset classes (crypto-assets, bonds, shares) using the ASFL data:

$$Ownership_{ik} = \alpha + \beta_j E\&S_{ij} + \gamma X_i + \delta Z_i + \varepsilon_i \tag{1}$$

where $Ownership_{ik}$ indicates whether i-th individual owns k financial asset, with $k = crypto-assets, bonds, shares$. $E\&S_{ij}$ are i-th individual's preferences for environmental and social issues, for $j = E, S1, S2, E\&S1, E\&S2$ (see Table A.1 in Appendix). X_i represents a set of control variables relevant for individual i's investment decisions, such as age, gender, education, objective and self-assessed financial literacy, risk aversion, income, etc. To absorb time-invariant cross-sectional variation e.g., in informal institutions, social norms across Austrian provinces, we include regional fixed effects, Z_i, in all regressions. As usual, ε_i denotes the error term.

The fact that an individual chooses a certain portfolio allocation might itself affect E&S preferences via different channels such as reading about related developments, being in contact with an investment fund manager or being identified and targeted as a specific consumer for reasons of marketing, though we try to minimise such omitted variable bias by saturating the regression model with economically-relevant covariates related to higher education and financial literacy.

Despite the useful guidance of accumulated evidence from previous studies, it is impossible to know if all important variables have been included. Hence the concern of the E&S endogeneity remains. To address remaining confounders related to potentially endogenous E&S preferences, we use an instrumental variables (IV) approach. Linear regression models containing endogenous regressors are generally identified using outside information such as exogenous

external instruments or by parametric distribution assumptions.

As argued above, in our main model (see equation (1)), $E\&S_{ij}$ preferences can be viewed as endogenous and hence correlated with ε_i. In the ASFL data, we have no exclusion assumption, meaning we have no outside source of instruments. As shown by Lewbel (2012), in such situations the model can be identified by exploiting variation on higher moment conditions of the first-stage error distribution. Identification is achieved by constructing regressors that are uncorrelated with the product of heteroskedastic errors, which is a feature of our data (see Table 2), where error correlations are due to an unobserved common factor.

Following Lewbel (2012) we first regress endogenous preferences, $E\&S_{ij}$, on a constant and a set of covariates X_i: $E\&S_{ij} = \psi X_i + \omega_i$. Then we take the estimated residuals $\hat{\omega}_i$ from the first-stage regression and let $R_i = \left(X_i - \bar{X}\right)\hat{\omega}_i$, where $\bar{X}$ is the sample average of X_i. Lewbel (2012) shows that under certain assumptions regarding heteroskedasticity, R_i is a valid vector of instruments for $E\&S_{ij}$ in the equation (1), resulting in consistent estimates.

4 Results

4.1 Main results

Our baseline model specifications of equation (1) – M1 and M2 – consider alternative composite E&S variables alongside the above detailed explanatory variables. The estimation results employing baseline OLS and Lewbel (2012) IV approach (correcting for potential endogeneity of the E&S preferences) for crypto-assets, bonds, and shares are displayed in Table 2. For a comparison with baseline results, we estimate additional 4 OLS specifications of equation (1) in order to account for potential multi-collinearity between the explanatory variables and to check the robustness of the estimated coefficients. Models 3 and 4 consider E&S variables individually alongside the relevant socio-economic explanatory variables. Models 5 and 6 are similar to Models 3 and 4 except that they also include financial literacy and financial self-confidence. The estimated OLS results are reported in Table 3, Table 4 and Table 5 for crypto-assets, bonds, and

shares, respectively.

A striking key result is that the non-pecuniary effect hypothesis cannot be rejected based on the ASFL data: E&S-consciousness of investors has a statistically significant impact on individual portfolio exposure to crypto-assets. We observe this positive significant effect of E&S preferences on crypto-asset portfolio composition for both model specifications in the IV estimations in Table 2. This novel result is also confirmed across most OLS specifications in Table 3: in M1, M2, M4 and M6. Contrary to a typical crypto-asset perception generated by news media with respect to their ESG footprint, our results indicate that retail investors with stronger E&S preferences invest more likely in crypto-assets than their less E&S-conscious peers.

Turning to augmented OLS models, they provide an additional specification and robustness checks by confirming that environmental attitudes have a stronger impact on crypto-assets holdings than social attitudes of investors. Further, composite E&S indicators tend to be more statistically significant than individual environmental and social attitudes. This result is also confirmed by IV estimates[10] reported in Table 2 where all E&S coefficients are statistically significant and their magnitude is significantly greater than in OLS models.

The results in Table 2 and Table 3 further show that investment in crypto-assets varies by how risk averse investors are in their portfolio choices, by investor's financial literacy and age. Financially better educated and more risk-taking investors are more likely to invest in crypto-assets – a result also found in the recent empirical literature (e.g. Fujiki, 2021). Regarding age, older individuals are less likely to invest in crypto-assets – as expected.

These results are in line with the previous literature (e.g. Krueger et al., 2020), as investors receive imperfect signals about the crypto-asset ESG footprint, which usually come from public sources such as news media or from their own idiosyncratic observations. Both risk and ambi-

[10] First-stage regression results of the Lewbel (2012) approach are reported in Table A.2. Holding other things equal, E&S attitudes negatively correlate with being female, with age and with the level of individuals' financial literacy. The result of negative correlation between financial literacy and E&S attitudes is well supported by the recent empirical literature (e.g. Rossi et al., 2019; D'hondt et al., 2022), which might point to the fact that financially literate individuals care about pecuniary aspects of investing rather than non-pecuniary aspects. On the other hand, E&S preferences are higher for individuals residing in Western and Southern Austria (as compared to the industrial Eastern Austria) and risk-loving individuals.

guity lead to a cautious investor behaviour and an uncertainty premia in asset markets; learning under risk and ambiguity generates asymmetric responses to ESG-news. ESG preferences affect investment decisions because they serve as a proxy for value-relevant information or risk, they enhance performance or reduce risk.

As a benchmark, we compare the crypto-asset holding probabilities with holding probabilities of traditional risky assets, namely bonds and shares in Table 2. While the estimated relationship between E&S preferences and crypto holdings is positive and statistically significant, we do not find such a statistically significant relationship between E&S preferences and the probability to hold bonds or shares. OLS estimates in Table 4 and Table 5 confirm these findings. This result finds strong support in the recent empirical literature on ESG investing. For example, Anderson and Robinson (2021) have not found any statistically significant relationship between individuals' ESG attitudes and ownership of pro-environment portfolios (green bonds, stocks, and pension funds) in a sample of Swedish households. This implies that in our estimations, which are based on the AFLS data that do not identify separately E&S bonds/stocks and non-E&S assets, the relationship between E&S preferences and the probability to hold traditional assets are even less likely to be present if the findings of Anderson and Robinson (2021) were generalisable for Austria.

Table 2: Results on E&S preferences for financial assets (OLS and Lewbel (2012) IV method)

	Crypto-assets				Bonds				Shares			
	(M1) OLS	(M1) IV	(M2) OLS	(M2) IV	(M1) OLS	(M1) IV	(M2) OLS	(M2) IV	(M1) OLS	(M1) IV	(M2) OLS	(M2) IV
E&S1	0.008*	0.026**			0.004	0.010			-0.006	-0.010		
	(0.005)	(0.012)			(0.005)	(0.014)			(0.009)	(0.029)		
E&S2			0.010**	0.028*			-0.003	-0.001			-0.012	-0.024
			(0.005)	(0.015)			(0.006)	(0.015)			(0.009)	(0.034)
Objective fin. literacy	0.013**	0.014**	0.016***	0.017***	0.001	0.001	0.002	0.002	0.016*	0.016*	0.016**	0.015*
	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.009)	(0.009)	(0.008)	(0.009)
Confidence in own fin. knowledge	0.013*	0.013*	0.013*	0.013*	0.013	0.013	0.012	0.012	0.019	0.020	0.022**	0.022**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.009)	(0.009)	(0.008)	(0.008)	(0.012)	(0.012)	(0.011)	(0.011)
Risk attitude score	0.056***	0.054***	0.058***	0.053***	0.044***	0.044***	0.049***	0.048***	0.128***	0.129***	0.127***	0.130***
	(0.014)	(0.014)	(0.014)	(0.013)	(0.012)	(0.012)	(0.012)	(0.013)	(0.018)	(0.018)	(0.017)	(0.019)
Secondary education	0.004	0.004	0.003	0.002	0.032*	0.032*	0.024	0.024	0.042	0.042	0.027	0.028
	(0.016)	(0.016)	(0.014)	(0.015)	(0.018)	(0.018)	(0.016)	(0.016)	(0.030)	(0.030)	(0.026)	(0.025)
Tertiary education	-0.025	-0.023	-0.029	-0.024	0.075*	0.076*	0.064	0.064	0.092*	0.091*	0.062	0.059
	(0.026)	(0.026)	(0.024)	(0.025)	(0.043)	(0.043)	(0.041)	(0.040)	(0.055)	(0.054)	(0.050)	(0.047)
Individual monthly net income	-0.000	-0.000	-0.000	-0.000	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gender: female	-0.008	-0.003	0.004	0.008	-0.004	-0.003	-0.017	-0.016	0.011	0.010	-0.005	-0.007
	(0.012)	(0.013)	(0.013)	(0.014)	(0.016)	(0.017)	(0.015)	(0.015)	(0.020)	(0.021)	(0.019)	(0.019)
Age	-0.001**	-0.001**	-0.001**	-0.001**	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.155***	-0.121*	-0.175***	-0.129	-0.306***	0.007	-0.242***	0.070	-0.472***	0.167	-0.389***	0.243
	(0.049)	(0.070)	(0.049)	(0.084)	(0.066)	(0.086)	(0.061)	(0.090)	(0.111)	(0.173)	(0.104)	(0.199)
Regional fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R2	0.10		0.11		0.12		0.12		0.21		0.21	
N	902	902	1,000	1,000	904	904	998	998	903	903	1,000	1,000
Cragg-Donald Wald F statistic		11.43		16.09		11.59		16.61		11.59		16.28
Hansen J statistic		8.89		8.49		9.55		11.95		12.95		7.79
Hansen J statistic (p-value)		0.45		0.49		0.39		0.22		0.16		0.56
Breusch-Pagan test for heteroskedasticity		5.47		23.41		5.36		22.91		5.22		22.18
Breusch-Pagan test heteroskedasticity (p-value)		0.02		0.00		0.02		0.00		0.02		0.00

Note: Regressions estimated using survey weights. Robust standard errors are reported in parentheses. Dummy variable for 'Primary education' category is the reference category of the respective dummy variables set. All RHS covariates (i.e. instruments) in the IV models have been generated according to the Lewbel (2012) methodology which is implemented within the Stata 'ivreg2h' estimation command (Baum and Lewbel, 2019).
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: ASFL 2019

Table 3: Results on E&S preferences for crypto-assets (OLS)

	(M1)	(M2)	(M3)	(M4)	(M5)	(M6)
Preferences for enviro. issues (E)			0.004	0.011**	0.005	0.012**
			(0.005)	(0.005)	(0.005)	(0.005)
Preferences for social issues (S1)			0.011		0.013	
			(0.008)		(0.008)	
Preferences for social issues (S2)				0.004		0.007
				(0.007)		(0.007)
E&S1	0.008*					
	(0.005)					
E&S2		0.010**				
		(0.005)				
Objective fin. literacy	0.013**	0.016***			0.013**	0.015***
	(0.006)	(0.005)			(0.006)	(0.006)
Confidence in own fin. knowledge	0.013*	0.013*			0.013*	0.013*
	(0.007)	(0.007)			(0.007)	(0.007)
Risk attitude score	0.056***	0.058***	0.058***	0.060***	0.056***	0.059***
	(0.014)	(0.014)	(0.014)	(0.013)	(0.014)	(0.014)
Secondary education	0.004	0.003	0.018	0.021	0.004	0.004
	(0.016)	(0.014)	(0.017)	(0.015)	(0.016)	(0.014)
Tertiary education	-0.025	-0.029	0.002	0.001	-0.024	-0.029
	(0.026)	(0.024)	(0.024)	(0.021)	(0.026)	(0.024)
Individual monthly net income	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gender: female	-0.008	0.004	-0.014	-0.002	-0.008	0.004
	(0.012)	(0.013)	(0.013)	(0.013)	(0.012)	(0.013)
Age	-0.001**	-0.001**	-0.000	-0.001**	-0.001*	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-0.155***	-0.175***	-0.069*	-0.080**	-0.157***	-0.174***
	(0.049)	(0.049)	(0.036)	(0.034)	(0.050)	(0.050)
Regional fixed effects	YES	YES	NO	NO	YES	YES
R2	0.10	0.11	0.08	0.09	0.10	0.11
N	902	1,000	914	1,016	902	1,000

Note: Regressions estimated using survey weights. Robust standard errors are reported in parentheses. Dummy variable for 'Primary education' category is the reference category of the respective dummy variables set.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: ASFL 2019

Table 4: Results on E&S preferences for bonds (OLS)

	(M1)	(M2)	(M3)	(M4)	(M5)	(M6)
Preferences for enviro. issues (E)			-0.002	-0.002	-0.001	-0.002
			(0.006)	(0.006)	(0.007)	(0.006)
Preferences for social issues (S1)			0.011		0.011	
			(0.008)		(0.009)	
Preferences for social issues (S2)				-0.004		-0.005
				(0.010)		(0.011)
E&S1	0.004					
	(0.005)					
E&S2		-0.003				
		(0.006)				
Objective fin. literacy	0.001	0.002			0.002	0.002
	(0.006)	(0.005)			(0.006)	(0.005)
Confidence in own fin. knowledge	0.013	0.012			0.012	0.012
	(0.009)	(0.008)			(0.009)	(0.008)
Risk attitude score	0.044***	0.049***	0.047***	0.050***	0.045***	0.049***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Secondary education	0.032*	0.024	0.037**	0.031*	0.032*	0.025
	(0.018)	(0.016)	(0.018)	(0.016)	(0.018)	(0.016)
Tertiary education	0.075*	0.064	0.085**	0.074*	0.076*	0.063
	(0.043)	(0.041)	(0.042)	(0.041)	(0.043)	(0.042)
Individual monthly net income	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gender: female	-0.004	-0.017	-0.008	-0.019	-0.004	-0.017
	(0.016)	(0.015)	(0.016)	(0.015)	(0.016)	(0.015)
Age	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.306***	-0.242***	-0.271***	-0.211***	-0.309***	-0.241***
	(0.066)	(0.061)	(0.055)	(0.052)	(0.067)	(0.062)
Regional fixed effects	YES	YES	NO	NO	YES	YES
R2	0.12	0.12	0.11	0.11	0.12	0.12
N	904	998	916	1,014	904	998

Note: Regressions estimated using survey weights. Robust standard errors are reported in parentheses. Dummy variable for 'Primary education' category is the reference category of the respective dummy variables set.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: ASFL 2019

Table 5: Results on E&S preferences for shares (OLS)

	(M1)	(M2)	(M3)	(M4)	(M5)	(M6)
Preferences for enviro. issues (E)			-0.012	-0.011	-0.012	-0.012
			(0.010)	(0.010)	(0.011)	(0.010)
Preferences for social issues (S1)			0.000		0.003	
			(0.010)		(0.011)	
Preferences for social issues (S2)				-0.016		-0.013
				(0.012)		(0.013)
E&S1	-0.006					
	(0.009)					
E&S2		-0.012				
		(0.009)				
Objective fin. literacy	0.016*	0.016**			0.017**	0.016**
	(0.009)	(0.008)			(0.009)	(0.008)
Confidence in own fin. knowledge	0.019	0.022**			0.019	0.022**
	(0.012)	(0.011)			(0.012)	(0.011)
Risk attitude score	0.128***	0.127***	0.131***	0.130***	0.128***	0.127***
	(0.018)	(0.017)	(0.018)	(0.017)	(0.018)	(0.017)
Secondary education	0.042	0.027	0.058**	0.047*	0.042	0.027
	(0.030)	(0.026)	(0.029)	(0.024)	(0.029)	(0.026)
Tertiary education	0.092*	0.062	0.121**	0.093**	0.093*	0.062
	(0.055)	(0.050)	(0.052)	(0.047)	(0.054)	(0.050)
Individual monthly net income	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gender: female	0.011	-0.005	0.001	-0.013	0.011	-0.005
	(0.020)	(0.019)	(0.021)	(0.019)	(0.020)	(0.019)
Age	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.472***	-0.389***	-0.349***	-0.269***	-0.475***	-0.389***
	(0.111)	(0.104)	(0.080)	(0.078)	(0.110)	(0.104)
Regional fixed effects	YES	YES	NO	NO	YES	YES
R2	0.21	0.21	0.20	0.19	0.21	0.21
N	903	1,000	915	1,016	903	1,000

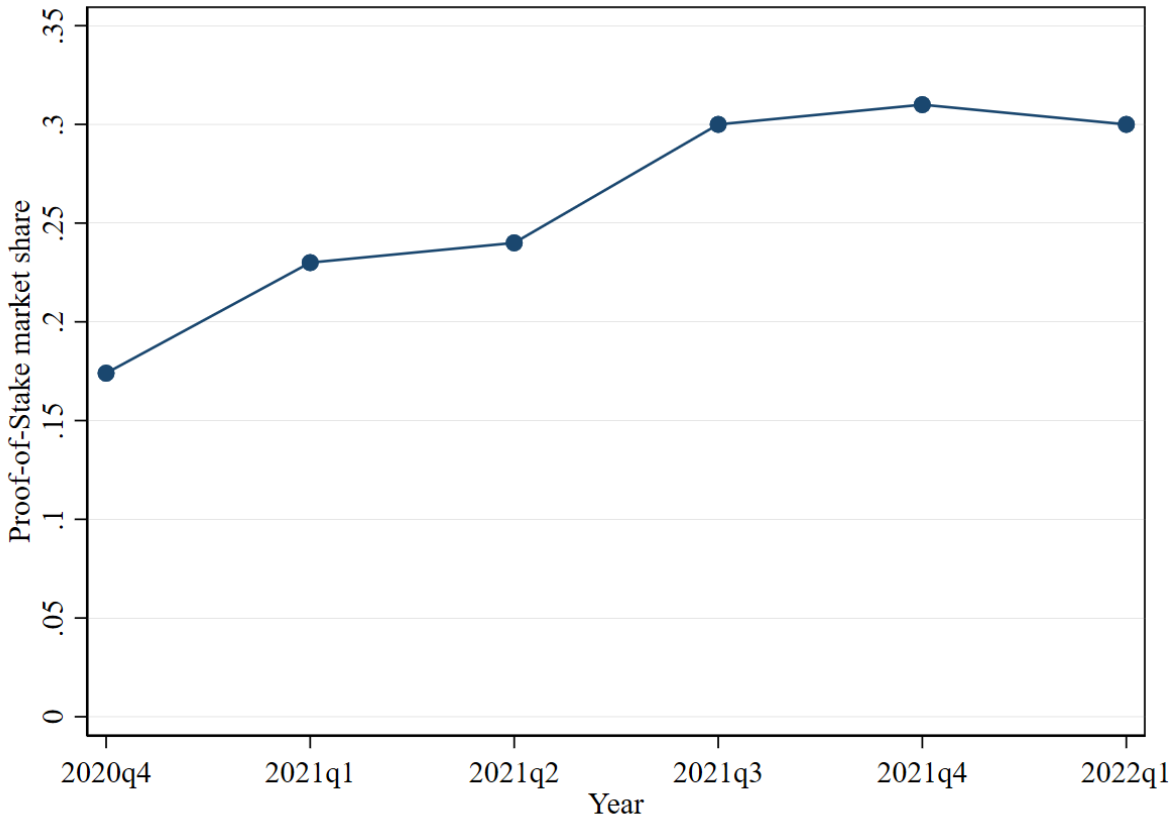
Note: Regressions estimated using survey weights. Robust standard errors are reported in parentheses. Dummy variable for 'Primary education' category is the reference category of the respective dummy variables set.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: ASFL 2019

For the household finance literature that studies determinants of portfolio holdings, our results add a further piece of evidence that non-pecuniary effects indeed matter in explaining cross-sectional differences in investment decisions; whereby the association between E&S preferences and crypto-assets is stronger compared to traditional risky assets like bonds and shares.

There are two recently documented facts that support our findings. On the supply side, many crypto-assets have a low (even zero) ESG footprint, including the Proof-of-Stake (PoS)

class of consensus mechanisms and the usage of renewable energy sources for mining. Moreover, the share of sustainable crypto-assets is increasing continuously. For example, since its introduction 10 years ago, the PoS market share has reached 30% in 2021 (see Figure 3), its energy consumption is substantially lower compared to the PoW class. Even the PoW-based blockchains are increasingly "decarbonised" by being mined using renewable energy sources like solar, hydro or wind power, e.g. in Iceland and Norway (Crypto Climate Accord). Indeed, the wide range of cross-sectional distributions within the crypto-asset class allows forward-looking ESG-conscious investors to match closely their preferences, subjective beliefs, ESG performance, risk aversion, etc. (see Saleh, 2021).

Figure 3: Evolution of Proof-of-Stake market share over time



Source: Based on data from https://staking.staked.us/state-of-staking

On the demand side, the underlying ASFL data cover individual investors, who compared to large corporate crypto-asset holders tend to have stronger non-traditional (imperfectly rational) preferences for the portfolio ESG footprint (Mustafa et al., 2022). Further, retail crypto investors are young, above-average educated, and financially more literate compared to the general population, and younger cohorts tend to have stronger environmental concerns than older cohorts (Stix, 2021; Fujiki, 2021). In the era of digital disruption, which is continuing to fragment the crypto-asset market, and the growing number of investment tools hitting the market empower small individual ESG-conscious investors by giving them the ability to take control of whether their money is being invested for good in the world.

For the crypto-asset literature, the evidence we provide is supportive of crypto-asset-related

environmental concerns (e.g. high energy consumption in the PoW mining) being of first-order for crypto holdings, whereas social issues (e.g. financial inclusion) of second-order. That is, E&S-conscious investors tend to invest more often in crypto-assets even though in the general crypto-asset class there are also cryptocurrencies with adverse environmental effects, for example, due to high energy consumption. The existence of alternative less energy-intensive consensus mechanisms, e.g., the PoS is much less energy intensive than PoW, and the usage of renewable energy sources for mining may explain our results (Platt et al., 2021). We find less support for a causal relationship between non-pecuniary effects related to social preferences in Austrian individual investor portfolio exposure to crypto-assets.

4.2 Further analysis and robustness

We estimate several additional models serving as robustness checks, for diagnostic purposes and transparency. First, we check if the coefficients remain stable after accounting for possible nonlinearities in effects of age and income. The results suggest that even considering the non-linear quadratic terms do not alter our main set of estimated E&S effects (see Table A.3 in Appendix).

Second, given the binary nature of our dependent variable (ownership of crypto-assets), we estimate a set of probit regressions (results shown in Table A.4) to check the robustness of our main OLS estimates presented in Table 2 through Table 5. We can see that probit marginal effects are somewhat smaller compared to OLS, but still similar in magnitude.

Finally, given the rare occurrence of the crypto-assets owners (around 3% of the sample), simple OLS or probit estimates might suffer from bias as suggested by King and Zeng (2001). Therefore, we have re-estimated our main OLS and probit models by means of a rare-events logit model.[11] We report estimated results from three estimation procedures next to each other in Table A.4 in Appendix and can see that the OLS/LPM estimates are quite close to the marginal

[11] To estimate the rare-events logit model, we use the Stata estimation command 'relogit' implemented by Tomz et al. (2021).

effects obtained from the estimated coefficients for rare-events logit model. This supports the OLS estimation approach also in the 2SLS IV framework.

5 Conclusions

We studied the relevance of non-pecuniary effects in driving cross-sectional differences in investment decision. In particular, we examined the relationship between E&S preferences and holdings of crypto-assets; and compared how the investors' E&S preferences effect on investment decisions differ between crypto-assets and traditional financial assets.

Our results suggest that on average individuals with stronger E&S preferences tend to invest more frequently in crypto-assets than less E&S-conscious investors. Second, the association between environmental attitudes and crypto investments is of first-order, whereas social attitudes do not determine the portfolio exposure to crypto-assets of E&S-conscious investors. Our paper delivers a novel evidence regarding the E&S preferences of individual investors exhibiting a subjective belief dynamics - in line with the household finance literature finding that a priori stated socially "desirable" preferences do not always match the preferences revealed in the portfolio choice (Anderson and Robinson, 2021). Contrary to a typical crypto-asset perception generated by news media with respect to their ESG footprint, our results indicate that retail investors with stronger E&S preferences invest more likely in crypto-assets than their less E&S-conscious peers. However, there are also other potential reasons why such a result could actually be in line with consistent preferences with regard to communication and actual portfolio choice.

On the supply side, many new generation crypto-assets have an extremely low ESG footprint, including the PoS class of consensus mechanisms and the usage of green renewable energy sources in mining. Moreover, the share of sustainable crypto-assets is continuously increasing. The wide range of distributions within the crypto-asset class allows forward-looking ESG-conscious investors to match closely their preferences, subjective beliefs, ESG performance, risk

aversion, etc. On the demand side, the digital disruption which is continuing to fragment the crypto-asset market, and the growing number of investment tools available on the market attracts small individual ESG-conscious investors giving them the ability to take control of whether their money is being used in line with their ESG preferences. Indeed, the individual investors, who compared to large corporate crypto-asset holders tend to exhibit stronger non-pecuniary preferences for their portfolio ESG footprint, are young, above-average educated, and financially more literate compared to the general population.

These findings suggest that non-pecuniary effects of crypto-investors captured via environmental, social and ethical/moral preferences should be (and are already) taken into consideration, when designing new digital currencies, e.g. as is under discussion by a number of central banks. Second, the value added of the inclusion of separate items and more detailed information on crypto-assets and other alternative financial instruments in standard finance and wealth surveys becomes evident. Our results also highlight the need to collect detailed information on investor's beliefs and attitudes within the household portfolio context, beyond the standard socio-economic variables to better understand individual investment decisions.

While this paper delivered first insights, we strongly believe that more research is needed using larger household finance datasets which allow for a more detailed and comprehensive socio-economic analysis of the relationship of ESG preferences and portfolio choice with regard to crypto-assets. For this reason we call for an inclusion of crypto-asset questions into standard household finance surveys such as the Survey of Consumer Finances (US), The Wealth and Asset Survey (UK) or the Household Finance and Consumption Survey (Continental Europe). Only survey data which includes extensive and intensive margins of crypto-asset holdings along with the rest of the household balance sheet as well as a large number of socio-economic characteristics and preferences will allow to create a deeper understanding of portfolio choice with regard to crypto-assets. Such a micro-evidence-based understanding is urgently needed given the quick rise of crypto-assets especially among the younger investor cohorts, not only for potential regulation purposes but also to monitor the financial behaviour of households and potential risks

created for the financial stability.

Data Availability Statement

The paper uses non-public, individual-level microdata from the Austrian Survey of Financial Literacy (ASFL) collected by the Austrian Central Bank (Oesterreichische Nationalbank, OeNB). The ASFL data, which is part of the OECD/INFE 2020 International Survey of Adult Financial Literacy, can be officially applied for via an e-mail address: SecretariatINFE@oecd.org.

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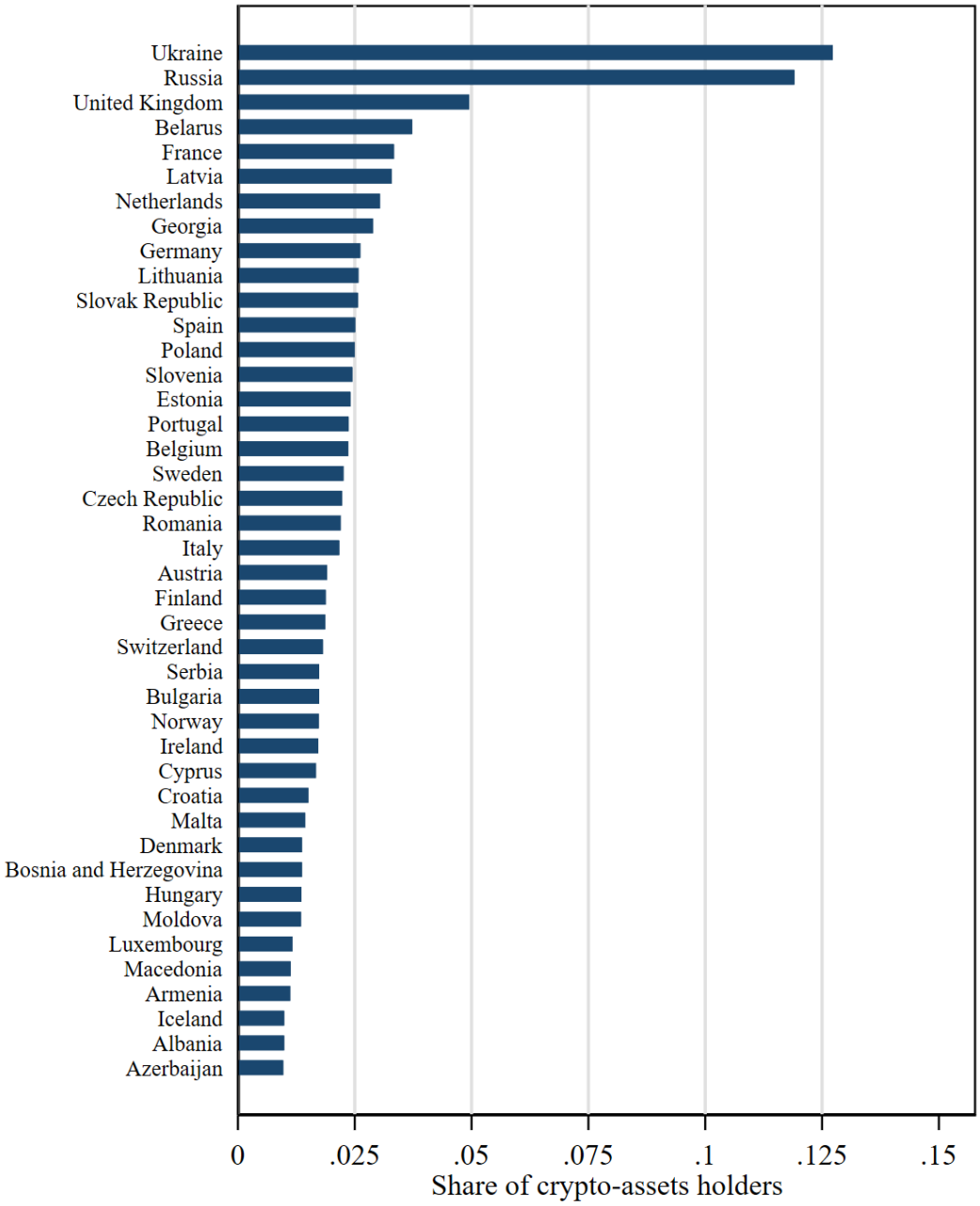
Appendix

Figure A.1: Share of population holding crypto-assets across Europe



Source: Based on data from https://triple-a.io/crypto-ownership/

Table A.1: Description of variables used in empirical analysis

Variable	Description
Crypto-assets ownership	Dummy variable equal to 1 if an individual currently owns crypto-assets (including initial coin offerings), and 0 otherwise
Bonds ownership	Dummy variable equal to 1 if an individual currently owns bonds, and 0 otherwise
Stocks/shares ownership	Dummy variable equal to 1 if an individual currently owns stocks / shares, and 0 otherwise
Preferences for enviro. issues (E)	Environmental attitudes score ranging from 1 to 5; based on the survey question: *"I think it is more important for investors to choose companies that are making a profit than to choose companies that are minimising their impact on the environment"*
Preferences for social issues (S1)	Social attitudes score ranging from 1 to 5; based on the survey question: *"I prefer to use financial companies that have a strong ethical stance"*
Preferences for social issues (S2)	Social attitudes score ranging from 1 to 5; based on the survey question: *"I am honest even if it puts me at a financial disadvantage"*
E&S1 (E + S1)	Combined environmental/social score by summing E and S1 variables
E&S2 (E + S2)	Combined environmental/social score by summing E and S2 variables
Objective fin. literacy	Financial literacy score ranging from 0 to 7; based on correct answers to 7 financial literacy survey questions (time value of money, interest paid on loan, interest plus principal, compound interest, risk and return, definition of inflation, diversification), see OECD (2018) for details
Confidence in own fin. knowledge	Self-rated knowledge of financial matters ranging from 1 "very low" to 5 "very high"
Risk attitude score	Willingness to take investment risk ranging from 1 "never" to 4 "always"
Education	Dummy variables set for the three main education categories: no or primary education, secondary education, tertiary education
Individual monthly net income	Individual monthly net income in euros. "Continuous" income is generated as mid points from very detailed income intervals asked to respondents: 0 - 450, 450 - 600, ..., 4800 - 5100, 5100 and above. Hence, measured income is top-coded
Gender	Dummy variable equal to 1 if female, and 0 otherwise
Age	Age in years
Region	Dummy variables set for the three main regions: Region of East Austria, Region of South Austria, and Region of West Austria

Source: Own processing based on the ASFL 2019 questionnaire

Table A.2: First-stage regression results (OLS)

	Crypto-assets		Bonds		Shares	
	(1)	(2)	(3)	(4)	(5)	(6)
	E&S1	E&S2	E&S1	E&S2	E&S1	E&S2
Objective fin. literacy	-0.041	-0.075**	-0.038	-0.071**	-0.037	-0.073**
	(0.037)	(0.031)	(0.037)	(0.031)	(0.037)	(0.031)
Confidence in own fin. knowledge	0.022	0.024	0.021	0.025	0.020	0.023
	(0.057)	(0.049)	(0.057)	(0.048)	(0.057)	(0.048)
Risk attitude score	0.098	0.279***	0.098	0.277***	0.096	0.279***
	(0.069)	(0.059)	(0.069)	(0.059)	(0.069)	(0.059)
Secondary education	-0.018	0.066	-0.018	0.061	-0.016	0.070
	(0.165)	(0.134)	(0.164)	(0.133)	(0.164)	(0.133)
Tertiary education	-0.093	-0.279	-0.095	-0.311	-0.097	-0.278
	(0.231)	(0.195)	(0.230)	(0.195)	(0.230)	(0.194)
Individual monthly net income	-0.000	0.000	-0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gender: female	-0.277**	-0.231**	-0.274**	-0.225**	-0.279***	-0.226**
	(0.108)	(0.092)	(0.108)	(0.092)	(0.108)	(0.092)
Age	-0.001	-0.006**	-0.001	-0.006**	-0.001	-0.006**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Region of South Austria	0.273**	0.407***	0.273**	0.400***	0.269**	0.403***
	(0.134)	(0.116)	(0.134)	(0.115)	(0.134)	(0.115)
Region of West Austria	0.167	0.333***	0.155	0.323***	0.150	0.325***
	(0.117)	(0.100)	(0.117)	(0.099)	(0.117)	(0.099)
Constant	6.008***	5.761***	5.996***	5.736***	6.001***	5.743***
	(0.336)	(0.276)	(0.336)	(0.275)	(0.336)	(0.275)
R2	0.02	0.09	0.02	0.09	0.02	0.09
N	902	1,000	904	998	903	1,000

Note: Regressions estimated using survey weights. Standard errors are reported in parentheses. Dummy variables for 'Primary education' and 'Region of East Austria' categories are the reference categories of the respective dummy variables sets.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: ASFL 2019

Table A.3: Robustness of results on E&S preferences for crypto-assets (OLS, nonlinear effects of age and income)

	(1)	(2)	(3)	(4)	(5)	(6)
E&S1	0.008*	0.008*	0.008*			
	(0.005)	(0.005)	(0.005)			
E&S2				0.010**	0.010**	0.010**
				(0.005)	(0.005)	(0.005)
Objective fin. literacy	0.013**	0.013**	0.013**	0.016***	0.016***	0.016***
	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Confidence in own fin. knowledge	0.013*	0.013*	0.014**	0.013*	0.013*	0.014**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Risk attitude score	0.056***	0.056***	0.056***	0.058***	0.058***	0.058***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Secondary education	0.004	0.003	0.004	0.003	0.002	0.006
	(0.016)	(0.015)	(0.016)	(0.014)	(0.013)	(0.015)
Tertiary education	-0.025	-0.025	-0.024	-0.029	-0.030	-0.025
	(0.026)	(0.027)	(0.026)	(0.024)	(0.025)	(0.024)
Individual monthly net income	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Individual monthly net income squared		-0.000			-0.000	
		(0.000)			(0.000)	
Gender: female	-0.008	-0.008	-0.008	0.004	0.004	0.004
	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)
Age	-0.001**	-0.001**	-0.001	-0.001**	-0.001**	-0.003
	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.002)
Age squared			0.000			0.000
			(0.000)			(0.000)
Constant	-0.155***	-0.155***	-0.148***	-0.175***	-0.177***	-0.145***
	(0.049)	(0.051)	(0.056)	(0.049)	(0.049)	(0.053)
Regional fixed effects	YES	YES	YES	YES	YES	YES
R2	0.10	0.10	0.10	0.11	0.11	0.11
N	902	902	902	1,000	1,000	1,000

Note: Regressions estimated using survey weights. Robust standard errors are reported in parentheses. Dummy variable for 'Primary education' category is the reference category of the respective dummy variables set.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: ASFL 2019

Table A.4: Robustness of results on E&S preferences for crypto-assets (comparison of OLS, probit, and rare-events logit models)

	(1) OLS	(2) probit	(3) rare-events logit	(4) OLS	(5) probit	(6) rare-events logit
E&S1	0.008*	0.002	0.006			
	(0.005)	(0.002)	(0.006)			
E&S2				0.009**	0.003*	0.009*
				(0.004)	(0.002)	(0.005)
Objective fin. literacy	0.014**	0.004**	0.014*	0.017***	0.005***	0.018***
	(0.006)	(0.002)	(0.007)	(0.006)	(0.002)	(0.007)
Confidence in own fin. knowledge	0.012*	0.008**	0.018*	0.012*	0.006*	0.015*
	(0.007)	(0.004)	(0.009)	(0.007)	(0.003)	(0.008)
Risk attitude score	0.058***	0.016***	0.040***	0.061***	0.013***	0.042***
	(0.014)	(0.005)	(0.009)	(0.014)	(0.005)	(0.009)
Secondary education	0.003	0.003	-0.000	0.002	0.006	0.012
	(0.016)	(0.014)	(0.046)	(0.014)	(0.012)	(0.053)
Tertiary education	-0.023	-0.008	-0.029	-0.027	-0.003	-0.017
	(0.026)	(0.016)	(0.051)	(0.024)	(0.013)	(0.055)
Individual monthly net income	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gender: female	-0.008	-0.001	-0.005	0.004	0.004	0.009
	(0.012)	(0.005)	(0.015)	(0.013)	(0.005)	(0.014)
Age	-0.001**	-0.001***	-0.001***	-0.001**	-0.000***	-0.002***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
Regional fixed effects	YES	YES	YES	YES	YES	YES
R2	0.10			0.11		
Pseudo R2		0.27			0.30	
N	902	902	902	1,000	1,000	1,000

Note: For probit and rare-events logit models we report marginal effects (calculated at the means of explanatory variables). Rare-events logit models are estimated using 'relogit' Stata estimation command (Tomz et al., 2021). Regressions estimated using survey weights. Robust standard errors are reported in parentheses. Dummy variable for 'Primary education' category is the reference category of the respective dummy variables set.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: ASFL 2019

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