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The Interrelations of Cryptocurrency and Gambling: Results from a Representative Survey

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Abstract: Researchers have only recently begun investigating the associations between cryptocurrency and gambling, although the structural similarities of financial speculation and gambling and the risks for transferring harmful behavior from one activity to another have been subject to numerous studies in the past decade. This is noticeable since the societal relevance of cryptocurrencies steadily increases. Based on a survey from 2019, this study analyzed a representative sample of 3,864 Germans regarding their cryptocurrency and gambling use. The aim of the study was to determine differentiating factors between sole gamblers, sole cryptocurrency users and users of both as well as to uncover the socioeconomic profiles and behavioral patterns of the latter group. It was found that cryptocurrency users who also gamble are mostly young, male, well-educated and well-off and report significantly higher levels of domain-specific knowledge, ideological motivation and trust-perceptions about cryptocurrency as compared to the other groups. Using cluster analysis, the behavioral patterns of three distinct user groups were revealed, which differ by the intensity of their cryptocurrency involvement across mental, proactive and financial aspects. The observation that a considerable number of this technology-savvy population of users is considered heavy users indicates potential risks of over-involvement. The findings provide researchers and regulators with an improved understanding of the phenomenon of cryptocurrency and the psychological involvement of users.

Keywords: Cryptocurrency, cryptocurrency trading, cryptocurrency involvement, gambling, behavioral patterns, over-involvement

1. Introduction

The increasing prevalence of cryptocurrency and the increasing attention that blockchain technology receives in the economy, in politics and in society suggest that the disruptive potential of the technology may also develop noticeable effects on the gambling industry, regulators and gamblers. Despite these potentials, the functionalities of cryptocurrency and many implications for industry stakeholders, authorities and users are not fully understood. Cryptocurrencies are system-native digital assets with a wide range of purposes in economic coordination mechanisms of blockchain systems (Rauchs et al., 2018), e.g. as a remuneration for services associated with securing the immutability of the network's transaction database. Blockchain, the technology that underpins most cryptocurrencies, is a technical infrastructure centered around a distributed database which is collaboratively managed, maintained and secured by its network participants (Steinmetz et al., 2020; Ingold & Langer, 2021). The technology also offers a new mode of access for gamblers (Gainsbury & Blaszczynski, 2017; Gainsbury et al., 2016), e.g. to access "decentralized casinos" (Scholten et al., 2020) – gambling applications that build on blockchain infrastructure, operate transparently with cryptocurrency and enable gambling in a pseudo-anonymous, unregulated environment. Such decentralized casinos, however, have not yet gained noticeable traction among cryptocurrency users in terms of volume. Besides these disruptive technical capabilities of the technology, a growing literature focuses on another, more prevalent, intersection of cryptocurrency and gambling: the association between the mere trading of cryptocurrency and gambling. The majority of these studies examines the structural similarities between the two activities, whose users may experience mere-exposure effects (Zajonc, 2001). In extension to this, recent research suggests that also the mental aspects, e.g. trust in cryptocurrency and ideological motivation, play a substantial role for owners and users of cryptocurrency (e.g. Steinmetz et al., 2021). Despite of these findings, however, such psychological aspects of cryptocurrency use and how they may interrelate with gambling have so far not been recognized in the literature on the interrelations of cryptocurrency and gambling. In light of the increasing relevance of cryptocurrency in Western societies, e.g. in Germany (Mora et al., 2021), the increasing popularity of stock-trading applications (Stewart, 2020; Robinhood, 2021), and the fact that many of the latter's providers also offer cryptocurrency trading (e.g. Robinhood, 2018), it is of growing urgency to investigate not only the association between cryptocurrency trading and gambling but, more broadly, cryptocurrency involvement and gambling.

The proposition that cryptocurrency trading is associated with gambling is grounded in the structural similarity of the two activities: A situation in which highly volatile assets are traded with limited information and in the expectation of uncertain but high gains resembles the basic setup of gambling (Delfabbro et al., 2021), where stakes are placed on uncertain outcomes, though they are predominantly influenced by chance (Delfabbro et al., 2019). The motives to participate in either of the two activities are considered to be similar: According to Mills and Nower (2019), the hope for high gains explains the association between cryptocurrency trading and problem gambling. In line with these findings, the United Kingdom's Financial Conduct Authority (FCA; FCA, 2019) reported that, based on a survey of 2,132 British respondents, the purchase of cryptocurrency is most often intended as a gamble (31%), as portfolio

diversification (30%), or in the expectation of quick gains (18%). Similarities of gambling and cryptocurrency trading have also been found in the users' strategies. Senarathne (2019) investigates the similarities between cryptocurrency trading behavior and high-risk gambling. The author concludes that cryptocurrency trading can be considered a form of gambling in which the motivation comes from the riskiness of the payoffs. Furthermore, behavioral patterns known from gambling, e.g. chasing losses, also apply to excessive traders of cryptocurrency (Meng & Fu, 2020). Mills and Nower (2019) found that cryptocurrency trading is strongly associated with problem gambling, while Delfabbro et al. (2021) refined these findings by showing that scores for the Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001) and gambling involvement are reliable predictors of cryptocurrency trading intensity.

Apart from these findings, the associations between cryptocurrency trading and gambling are further supported by the similarities between cryptocurrency trading and stock trading. Griffiths (2018) classifies "crypto-trading addiction" as a sub-type of online day-trading addiction. Mills and Nower (2019) report an overlap between high-risk stock traders and cryptocurrency traders in excess of 75%. In fact, all three activities – cryptocurrency trading, stock trading and gambling – are associated with each other: For both cryptocurrency trading (Mills & Nower, 2019) and stock market trading (e.g. Mosenhauer et al., 2021), similarities to problem gambling have been found, while Delfabbro et al. (2021) found stock trading to be a predictor of the frequency of checking cryptocurrency prices and the time spent reading and researching about cryptocurrencies and their markets. Due to these overlaps, it is reasonable to assume that many findings about the more thoroughly investigated interrelations of stock trading and gambling can be assumed to also apply in the context of cryptocurrency trading and gambling. For example, Arthur, Delfabbro, and Williams (2015) compared stock traders who also gambled to pure gamblers from a Canadian panel. The former group played more often, engaged in more types of games and were more prone to gambling problems. The relation likely also holds for cryptocurrency users who also gamble, given the structural similarity of the activities.

Then again, several aspects differentiate stock trading from cryptocurrency trading. Regarding user characteristics, for example, Arthur, Delfabbro, and Williams (2015) found that day-traders in Canada were approximately 47 years on average, while Steinmetz et al. (2021) found that cryptocurrency users in Germany were aged on average 39 years. This indicates that traders of cryptocurrency are tendentially younger than stock traders. With reference to individuals who participate in both activities gambling and trading, a similar picture unfolds as gamblers who trade cryptocurrencies are younger than gamblers who traded high-risk stocks. Delfabbro et al. (2021) reported that most crypto-affine gamblers were 18 to 30 years old, male, had a bachelor's degree, and were employed and in a relationship. In comparison, day-traders in Australia who also gambled majorly above 45 years old and tendentially older than mere gamblers (Arthur & Delfabbro, 2016). In sum, however, little is known about the socioeconomics and demographics of cryptocurrency users who also gamble since most existing findings were not based on representative samples and many results have not yet been verified.

Another important difference between stock trading and engagement in cryptocurrency trading is that the latter holds the potential for more intense and multi-faceted individual involvement.

Unlike buying stocks of listed companies, buying cryptocurrency is predominantly associated with investing in early-stage ideas, concepts, startups, communities, narratives and even memes. To a considerable extent, the cryptocurrency industry appropriates the narrative of "decentralization", which portrays public permissionless blockchain systems as the resilient opposite to existing financial systems architecture with centralized powers (Walch, 2019). So the demand for cryptocurrencies is partly grounded in the foundational ideas of Bitcoin's creator(s), which shape the narratives of decentralized, transparent and self-governed alternative communities, as opposed to the established inflationary and dysfunctional financial systems and currencies. Thus, cryptocurrency users likely exhibit a different kind of mental involvement than stock owners. Although some previous studies, e.g. Steinmetz et al. (2021), found that the cryptocurrency purchase of Germans is ideologically motivated to a considerable extent, the existing literature focuses more the activity of cryptocurrency trading and much less on the important mental aspects of cryptocurrency involvement.

An important role in the narrative of decentralization accrues to blockchain technology, which technically underpins cryptocurrencies and facilitates the un-intermediated interactions within and between networks and their participants. The need for trust is reduced by replacing intermediaries with a computer protocol which achieves transactional security via deterministic computation (Antonopoulos, 2014; Werbach, 2016; De Filippi et al., 2020; Nakamoto, 2008). This implies that users have some measure of confidence, or trust, in the technology and in the cryptocurrency they are using. This suggestion is supported by Mendoza-Tello et al. (2019), who found that the perceived trustworthiness of cryptocurrencies promoted the intention to use them in e-commerce, and by Steinmetz et al. (2021), who reported significantly more trust in cryptocurrency by crypto-owners compared to non-owners. Further, high levels of trust were found to be a predictor of cryptocurrency ownership. In the context of trading and gambling, the role of trust could therefore differ between trading stocks versus cryptocurrency, which has not yet been recognized in the literature. Together with ideological motives, the users' trust would extend the scope of cryptocurrency involvement by a psychological dimension.

Another difference between cryptocurrency markets and stock markets concerns social media (Phillips & Gorse, 2018; Yu et al., 2021). Cryptocurrency markets are heavily influenced by events communicated through social media channels such as Twitter (e.g. Ante & Fiedler 2020; Ante, 2021) which shapes investor sentiment and cryptocurrency prices (Anamika et al., 2021). Because cryptocurrency markets are especially influenced by social media, it may be the case that cryptocurrency users are more intensely monitoring prices and social media activity (Subramaniam & Chakraborty, 2020) than stock traders and that such behavior is important in cryptocurrency's relation to gambling. While Delfabbro et al. (2021) were the first to measure respondents' cryptocurrency involvement intensity through an extensive set of variables – frequency of trading, daily monitoring intensity and daily engagement –, it is unclear whether the intensity of behavior is affected by the number of cryptocurrencies that the users own. The number of coins owned and its potential influence on user involvement thus requires further research. In sum, complementary to the division of cryptocurrency involvement by Delfabbro et al. (2021), several further aspects of involvement may influence cryptocurrency use and its relation to gambling.

While the current literature finds clear relations between cryptocurrency trading and gambling, little is known about the actual patterns of involvement of cryptocurrency users who also gamble. Cryptocurrency users' mental involvement in terms of trust and ideological motivation, which substantially shapes their mindsets (Steinmetz et al., 2021), has not yet been recognized in the context of cryptocurrency trading and gambling. To the best of our knowledge, only one of the reviewed studies modeled cryptocurrency involvement beyond the mere activity of trading. The fact that only one of the studies draws on a representative sample demonstrates that there is precious little established knowledge about this tech-affine subgroup in terms of their socioeconomics, demographics and cryptocurrency involvement. We therefore contribute to the scientific discourse by exploring patterns of cryptocurrency use and gamblers' involvement based on a representative cross-sectional survey of 3,864 Germans regarding their cryptocurrency knowledge, ownership, attitudes and usage. Using cluster analysis, this study follows research recommendations by Mills and Nower (2019) to explore for extensive behavioral patterns in cryptocurrency involvement by users who are also gamblers. To enhance the construct of "cryptocurrency involvement", we differentiate between mental, proactive and financial involvement, extending the model by Delfabbro et al. (2021). Additionally, by investigating the demographics and socioeconomics of cryptocurrency owners who also gamble, we contribute to closing the research gap identified by Scholten et al. (2020) concerning the personal characteristics of this tech-affine sub-population. The study aims to provide a scientific foundation for future research and identify those user groups which would benefit the most from protectory measures by answering the following research questions:

R1 Which variables differentiate cryptocurrency users who also gamble from users who are merely involved in either cryptocurrency or gambling?

R2 What is the demographic and socioeconomic profile of users involved in both cryptocurrency and gambling?

R3 Which patterns of cryptocurrency involvement can be found among cryptocurrency users who also gamble?

The paper is structured as follows: Section 2 describes the data, variables and methods. The results of the descriptive and multivariate analyses are presented in Section 3. The discussion of the results (Section 4) precedes some limitations (Section 5). Lastly, concluding remarks are presented in Section 6.

2. Material and methods

This section explains how the survey was conducted, who the subjects were (Subsection 2.1), and which variables were selected for the analyses (Subsection 2.2). Subsection 2.3 briefly introduces the approach of cluster analysis.

2.1. Data

The primary goal of the online survey was to gather representative data on the prevalence of the phenomenon of cryptocurrency, including ownership, usage domains, socioeconomics and demographics. The data is based on a sample of 3,864 adult German internet users – individuals who were online at least once a quarter during the previous year. The sample is representative of the German internet population with regard to age and sex and was conducted online between February and March 2019 by a German panel provider. Of 34,440 initially contacted panelists, 12.6% (4,326) responded. 276 respondents were rejected because of their IP address, browser cookies or browser fingerprints in order to prevent multiple participation, and another 184 participants were dropped manually because they answered suspiciously quickly. The manual removal was performed by the panel provider based on past experience with online surveys. Excluded responses were replaced to assure the representative character of the sample. Lastly, two more participants were removed manually because their response behavior was deemed inconsistent.

The panelists were invited by e-mail, and no indication was given as to the topic of the survey prior to participation to prevent self-selection bias. The panel participants were paid in accordance with the panel provider's terms of services: Panelists receive points which can be exchanged for money and the number of points received depends on the target group, complexity factors and survey length. The questionnaire itself filtered the participants twice: once according to their familiarity with the topic of cryptocurrency and, later on, according to whether they possess(ed) cryptocurrencies. Participants who met neither criterion were forwarded to provide only information on their sociodemographics and whether they participated in gambling during the last twelve months preceding the survey. Figure 1 visualizes the sample selection process.

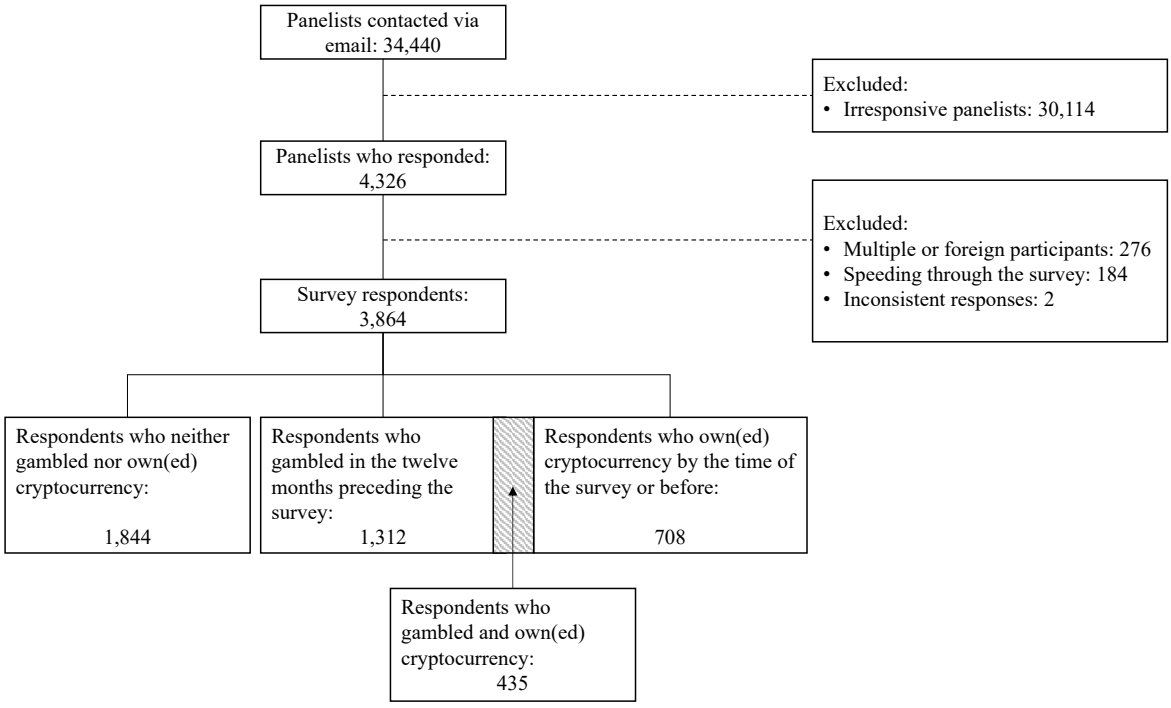

Figure 1. Sample selection process.

2.2. Variables

Information on the demographic and socioeconomic variables was gathered for the full sample. Besides *Age* (the only non-binary variable) and *Male*, it includes

- educational status, which was proxied by the respondents' highest educational achievement: NSE (no secondary education completed), GCSE equivalent, craft training, commercial training, A-level equivalent, higher education degree, PhD;
- income class: <500 EUR, 500–999 EUR, 1,000–1,499 EUR, 1,500–1,999 EUR, 2,000–2,999 EUR, 3,000–4,999 EUR, >5,000 EUR;
- social status: single, married, partnership, widowed, divorced/separated.

All respondents were asked to report their self-assessed knowledge about cryptocurrency and blockchain technology on a scale from zero to ten (Knowledge [0;10]), where zero equals no knowledge and ten indicates that the respondent perceives himself highly knowledgeable on the domain. Respondents who reported a knowledge level greater than zero were asked if they ever owned cryptocurrency (Currently, Past) and, if so, how many coins they own(ed) from a selection of the 15 most "valuable" cryptocurrencies by the time of the survey (#Coins, see the Appendix for the list of coins). In the following, ownership and use of cryptocurrency are referred to synonymously. Regarding their financial involvement, cryptocurrency owners were asked to report their portfolio value by the time of the survey (Portfolio value) and the amount of money they ever invested in cryptocurrency (excluding winnings from cryptocurrency speculation; Investment).

Respondents with positive knowledge were asked to report their level of trust in cryptocurrency (Trust [0;10]), and owners of cryptocurrency were asked to state their level of ideological motivation, i.e. to what extent they considered their ownership to be ideologically motivated (Ideological motivation/Ideology [0;10]). In line with the variables about respondents' knowledge, the scale for trust and ideological motivation indicates respondents' levels from low [0] to high [10]. With relation to trust, it was not specified in the survey, which aspects of cryptocurrency, e.g. the industry, the applied cryptographic means or in terms of a promising investment, respondents were to state their estimation of trustworthiness about because it would have been too domain-specific for respondents who were less knowledgeable on the matter. With relation to ideological motivation, and in opposition to most existing surveys on the matter, respondents were asked to report the strength to which they perceive their cryptocurrency ownership was influenced by their ideology or ideological motives, as opposed to reporting their actual ideological motivation.

Cryptocurrency owners were also asked to report the intensity with which they used cryptocurrency across a set of pre-defined usage domains: Access to Services, Criminal activity, Disguise of activity, Funding, Investment, Other, Payment, Speculation, and Voting. These usage domains were selected based on research by Steinmetz (2021) and Steinmetz et al. (2021). The authors derived these usage domains from the literature, which was existent by the time of the survey, and, to the best of our knowledge, assembled a comprehensive set of application domains for cryptocurrency by this time. The intensity was to be indicated by a

choice from seven values: daily (7), several times a week (6), once a week (5), several times a month (4), once a month (3), less than once a month (2), and not at all (1). As an example, respondents were asked to state how often they used their cryptocurrency for the purpose of speculating during the year preceding the survey from the scale described above. Finally, all respondents were asked if they had participated in gambling during the last twelve months prior to the survey (Gambling).

2.3. Statistical analyses

In line with the current state of the literature on the intersections of cryptocurrency usage and gambling, cluster analysis is applied as an explorative approach to find patterns of involvement in cryptocurrency among owners of cryptocurrency who also gamble. Because the variables on whose basis the clusters are determined are of a categorial and numerical nature, we use the Gower distance (Gower, 1971), a generalized coefficient of similarity which serves as an appropriate alternative distance measure when qualitative and quantitative variables are used simultaneously (Kuhn & Johnson, 2019). Partitioning Around Medoids (PAM) was used for clustering because of its comparative robustness compared to the k-means algorithm (Kaufman & Rousseeuw, 2005; Mächler et al., 2019). Since PAM uses actual observations as cluster centers instead of means, it is considered less sensitive to outliers and noise in the data (Kassambara, 2017).

The distributions of the variables speculation, #coins, and investment are right-skewed, whereas ideology and trust are left-skewed. Since the Gower distance is sensitive to non-normal distributions in general and outliers in continuous variables particularly, speculation, #coins, ideology, trust and investment were log-transformed prior to computing the distance matrix. The optimal number of clusters was determined according to the Silhouette width criterion (Walesiak & Dudek, 2010).

3. Results

In the following, the results of the descriptive and multivariate analyses are presented. The descriptive analyses address research questions R1 and R2, and they lay the foundation for selecting the variables for the clustering algorithm in the multivariate section, which relates to research question R3.

3.1. Descriptive analyses

The descriptive results include statistics on four focus groups, which we differentiate by their cryptocurrency ownership status and participation in gambling (Subsection 3.1.1). Subsection 3.1.2 reports the respondents' frequencies of use across the eight application domains.

3.1.1. Cryptocurrency users, gamblers and focus groups

Starting from the full sample (1), four groups were distinguished according to the respondents' participation in gambling in the preceding twelve months and cryptocurrency ownership:

Table 1. Descriptive statistics.

	Full sample (1)	Non-users (2)	Gamblers (3)	Crypto-users Total (4)	Crypto-users Past	Crypto-users Current	Crypto-gamblers Total (5)	Crypto-gamblers Past	Crypto-gamblers Current	t-test (3) Δ (4)	t-test (4) Δ (5)	t-test (3) Δ (5)	t-test (1) Δ (5)
Demographics													
Age	46.72	48.67	48.14	39.41	39.45	39.37	38.77	40.00	37.62	***		***	***
Male	0.51	0.41	0.55	0.64	0.59	0.70	0.71	0.65	0.76	***	*	***	***
Education													
NSE	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.01				
GCSE eq.	0.21	0.23	0.21	0.18	0.23	0.12	0.15	0.19	0.11			***	***
Craft training	0.14	0.15	0.16	0.11	0.09	0.14	0.09	0.09	0.09	**		***	***
Comm. training	0.22	0.22	0.23	0.16	0.15	0.18	0.19	0.13	0.25	***		*	
A-level eq.	0.16	0.15	0.14	0.18	0.18	0.17	0.22	0.26	0.18			***	***
Higher ed. d.	0.25	0.23	0.24	0.35	0.32	0.39	0.32	0.33	0.32	***		***	***
PhD	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.00	0.04				
Income (EUR)													
< 500	0.06	0.08	0.05	0.03	0.04	0.02	0.03	0.03	0.02			**	***
500 - 999	0.11	0.15	0.10	0.11	0.13	0.09	0.04	0.05	0.02		***	***	***
1,000 - 1,499	0.17	0.18	0.18	0.17	0.18	0.17	0.11	0.12	0.10		**	***	***
1,500 - 1,999	0.16	0.16	0.16	0.15	0.10	0.20	0.15	0.16	0.14				
2,000 - 2,999	0.22	0.20	0.23	0.25	0.27	0.22	0.28	0.30	0.26			*	***
3,000 - 4,999	0.17	0.13	0.19	0.22	0.23	0.22	0.27	0.20	0.35			***	***
> 5,000	0.04	0.04	0.04	0.04	0.04	0.05	0.09	0.10	0.09		***	***	***
Social Status													
Single	0.24	0.24	0.23	0.27	0.20	0.34	0.29	0.31	0.27			**	**
Married	0.43	0.40	0.46	0.42	0.42	0.43	0.44	0.37	0.50				
Partnership	0.20	0.19	0.19	0.22	0.29	0.15	0.24	0.29	0.19			**	**
Widowed	0.03	0.04	0.03	0.01	0.02	0.01	0.01	0.01	0.00			***	***
Divorced/Separated	0.10	0.13	0.10	0.07	0.06	0.08	0.03	0.02	0.04		**	***	***
Cryptocurrency use													
Current	0.09	-	-	0.48	-	1.00	0.52	-	1.00				***
Past	0.09	-	-	0.52	1.00		0.48	1.00	-				***
#Coins	0.18	-	-	0.93	-	1.93	1.06	-	2.03				***
Knowledge													
Cryptocurrency	3.76	2.76	3.58	6.32	5.72	6.97	6.90	6.24	7.51	***	***	***	***
Blockchain tech.	2.56	1.59	2.21	5.35	4.56	6.21	5.92	5.28	6.51	***	***	***	***
Psychological characteristics													
Trust	3.62	2.80	3.29	5.70	4.81	6.66	6.06	5.29	6.76	***	*	***	***
Ideology	5.97	-	-	5.57	-	5.57	6.20	-	6.20		**		**
Investment (EUR)													
Portfolio value	410.18	-	-	3,831.64	-	3,831.64	7,497.42	-	7,497.42		*		***
Investment amount	197.13	-	-	1,874.70	-	1,874.70	3,205.42	-	3,205.42				**
N	3,864	1,844	1,312	273	142	131	435	209	226				

* p<.1, ** p<.05, *** p<.01 (Student's *t*-test).

(2) Non-users, who neither gambled nor ever used cryptocurrency; (3) Gamblers, who had gambled recently but never owned cryptocurrency; (4) Crypto-users, who at some point owned cryptocurrency but had not gambled recently; and (5) Crypto-gamblers, who at some point owned cryptocurrency and had gambled recently. Subsamples (4) and (5) are furthermore divided according to past versus present cryptocurrency ownership. Table 1 shows descriptive statistics for these groups across demographic, socioeconomic, usage and ownership variables.

At first glance, any involvement in either gambling or cryptocurrency increases the likelihood of the respondents being young and male, compared to non-users. Furthermore, these likelihoods tend to increase from gamblers to crypto-users to crypto-gamblers. Current crypto-gamblers are 37 years old on average, and more than three-quarters of them are male. Cryptocurrency ownership, comprising both crypto-users and crypto-gamblers, is furthermore associated with higher education and income compared to non-users and gamblers. The younger age of cryptocurrency owners is reflected in their social status, with fewer widowed and divorced respondents. The far-right columns of Table 1 contain the results of testing the differences between different subsamples with respect to each variable. Crypto-gamblers appear to be more similar to crypto-users than to gamblers. This applies to demographics, socioeconomic characteristics and education, and to a lesser extent to income and social status. Crypto-users, on the other hand, share similarities with gamblers in terms of income and social status. Regarding the cryptocurrency-related variables knowledge and trust, gamblers, crypto-users and crypto-gamblers are quite distinct. While non-users and gamblers are rather sceptic of and less knowledgeable about cryptocurrency, cryptocurrency owners consider themselves better informed and have significantly more trust. Again, for crypto-gamblers, the outcomes are significantly higher than for pure crypto-users. This relation is further reflected in significantly higher levels of ideological motivation and larger investment.

3.1.2. Frequencies of cryptocurrency use

Table 2 contains descriptive statistics on the frequency with which crypto-users and crypto-gamblers engage in the cryptocurrency usage domains defined in Section 3.1. Crypto-gamblers are the heaviest users in all domains except “Other”. The two groups are significantly different apart from the frequency of “Other” uses and investment. The overall usage intensity, proxied by the sum of the reported usage across all domains, is 20% higher for crypto-gamblers than for mere crypto-users. The average frequency of use of crypto-gamblers exceeds that of crypto-users most strongly with respect to funding and speculation, both of which are associated with a high risk of financial loss.

Table 2. Frequencies of use across cryptocurrency application domains and subsamples.

	Full sample		(Current) crypto-user		(Current) crypto-gambler		Mann-Whitney-Wilcoxon test
	(1)		(4)		(5)		(4) Δ (5)
	m	M	m	M	m	M	U(effect size)
Access to services	2.73	2.00	2.35	1.00	2.95	3.00	12,304(.147)***
Criminal activity	1.97	1.00	1.73	1.00	2.11	1.00	13,252(.110)**
Disguise of activity	2.29	1.00	2.01	1.00	2.45	1.00	12,693(.135)**
Funding	2.40	1.00	1.98	1.00	2.65	1.00	12,308(.156)***
Investment	3.23	3.00	3.08	3.00	3.33	3.00	13,714(.062)
Payment	2.91	2.00	2.56	2.00	3.12	3.00	12,350(.141)***
Speculation	2.89	3.00	2.48	2.00	3.13	3.00	11,908(.167)***
Voting	2.18	1.00	1.89	1.00	2.36	1.00	12,698(.137)***
Other	3.42	2.50	4.20	4.00	2.86	2.00	23(.240)
Sum (usage intensity)	20.73	15.00	18.24	14.00	22.18	17.00	11,827(.168)***
N	357		131		226		

m, M and U represent the mean, median and Mann-Whitney-Wilcoxon test statistic; * p<.1, ** p<.05, *** p<.01

3.2. Multivariate analyses

The multivariate analysis aims at exploring for behavioral patterns among crypto-gamblers using cluster analysis. This section begins with the derivation of the variables of interest for the cluster analysis (Subsection 3.2.1), whose results, which we turn to in Subsection 3.2.2, serve to address research question R3. In Subsection 3.2.3, the clusters are further explored descriptively.

3.2.1. Variable selection and correlations

The descriptive results suggest that participation in gambling is associated with higher cryptocurrency engagement and usage. For the further analyses, based on both subjective considerations and the descriptive results, a set of variables were selected which can serve to differentiate crypto-gamblers from the other groups and which represent different aspects of involvement. The first such aspect is mental involvement. It comprises the variables ideological motivation and trust, in relation to both of which crypto-gamblers are significantly different from the other groups (Table 1). Secondly, the proactive dimension comprises the variables speculation, whose frequency also differentiates crypto-gamblers from crypto-users (Table 2), and the purchasing of multiple cryptocurrencies (#Coins). Lastly, although crypto-users do not differ significantly in this respect, we use the amount of investment to capture the respondents' financial involvement.

The Pearson correlations among the selected variables are shown in Table 3. Except for investment and gambling, all variables correlate positively and significantly ($p < .01$) with each other. While the strong correlation between trust and ideological motivation is intuitive, the

close association between ideological motivation and the frequency of speculation underlines how important the narratives and ideas that permeate the cryptocurrency industry are to the users. In contrast, the observation that ideological motivation does not correlate with investment and to a lesser extent with the number of coins indicates that only few cryptocurrencies correspond to the ideologies of the respondents and long-term financial involvement has no ideological background. Although trust in cryptocurrency and ideological motivation are highly correlated, only trust is associated with participation in gambling which suggests that both variables affect users of cryptocurrency very differently.

Table 3. Pearson correlation matrix of the variables for cryptocurrency involvement.

		(1)	(2)	(3)	(4)	(5)
Ideology	(1)					
Trust	(2)	**0.45**				
Speculation	(3)	**0.32**	**0.21**			
#Coins	(4)	**0.15**	**0.32**	**0.16**		
Investment	(5)	0.07	0.04	0.09	0.03	
Gambling	(6)	0.11	**0.15**	**0.18**	**0.09**	0.07

Significance at p <.01 is highlighted in bold.

3.2.2. Cluster analysis results

Table 4 shows the results of the cluster analysis. Three clusters were identified that distinguish crypto-gamblers in terms of the selected variables: Cluster 1 (n=107) is characterized by high mental, low active, and moderate financial involvement. Cluster 2 (n=79) includes the heavy users with strong involvement in mental, proactive, and financial terms. Cluster 3 (n=40) differs from the others in that the respondents are less involved. It is important to note that high, moderate or low involvement must be interpreted relatively to only the sample of all crypto-gamblers, not the subsamples of crypto-users, gamblers, or even the full sample. Figure 1 visualizes how the clusters compare to the average crypto-gambler.

The effect sizes of the Kruskal-Wallis test show that speculation ($H(2) = 130(0.57)$, $p < .001$) and ideology ($H(2) = 110.22(0.48)$, $p < .001$) have much greater impact on the clustering than trust ($H(2) = 48.83(0.21)$, $p < .001$) and #coins ($H(2) = 52.75(0.23)$, $p < .001$). This supports the observation crypto-gamblers are fairly homogeneous regarding their level of trust and the number of cryptocurrencies owned (#Coins). Clusters 1 and 3 are not significantly different in terms of speculation, #coins and investment, whereas they are in comparison of each of the two clusters with Cluster 2. The post hoc analysis shows that Cluster 1 and 3 are most similar to each other since for three of the five variables, non-significant differences have been found. In turn, users from Cluster 2 can be considered the most heterogeneous user group among all crypto-gamblers.

Table 4. Variables characterizing the mental, proactive and financial involvement of crypto-gamblers by clusters.

Involvement	All crypto-gamblers			Cluster 1			Cluster 2			Cluster 3				
Mental				high			high			low				
Active				low			high			low				
Financial				moderate			high			low				
Variables	m	M	IQR	m	M	IQR	m	M	IQR	m	M	IQR	H(effect size)	post hoc
Ideology	6.20	7	3.00	6.66	7	3.00	7.78	8	2.00	1.82	2	3.00	110.22(0.48)***	1:2, 1:3, 2:3
Trust	6.76	7	3.00	6.52	7	3.00	7.91	8	2.00	5.12	5	2.25	48.83(0.21)***	1:2, 1:3, 2:3
Speculation	3.13	3	3.75	2.06	2	2.00	5.10	5	2.00	2.12	2	2.00	130.00(0.57)***	1:2, 2:3
#Coins	2.04	1	1.75	1.71	1	1.00	2.80	2	1.00	1.40	1	1.00	52.75(0.23)***	1:2, 2:3
Investment	5,639.65	200	1,999.50	4,459	200	1,069	8,637	400	2,992	2,880	11	500	7.56(0.25)**	2:3
N	226			107			79			40				
Silhouette avg. width				0.40			0.19			0.17				

m, M, IQR, H represent the mean, median, inter-quartile range and Kruskal-Wallis test statistic. The post hoc column lists pairwise comparisons of clusters using Dunn's test; listed pairs of clusters are significantly different at $p<.05$.

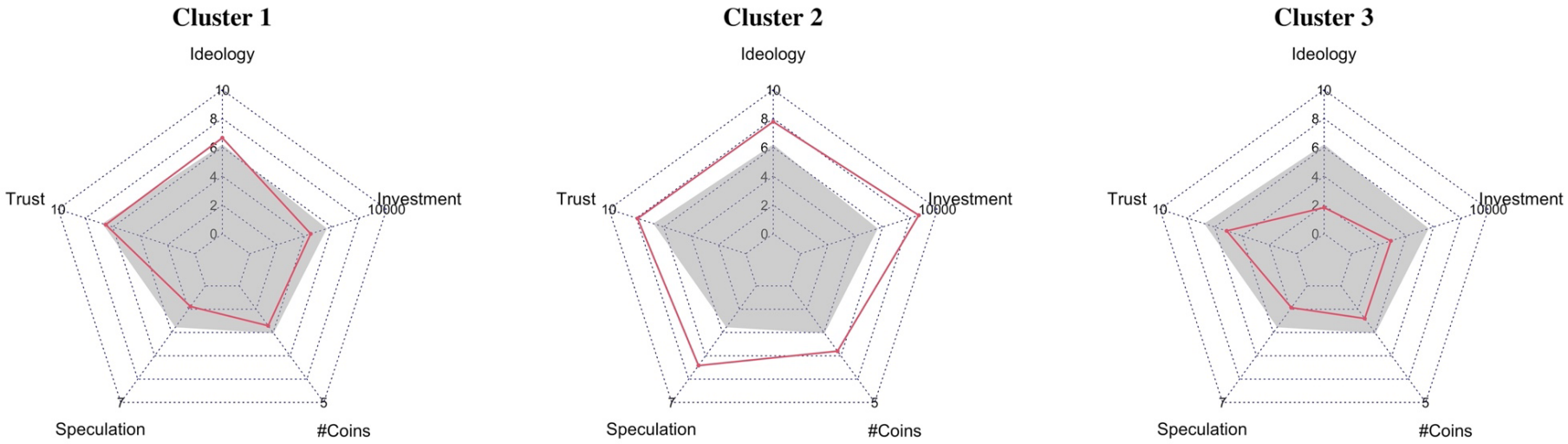

Figure 2. The three clusters depicted as radar plots.

3.2.3. Comparison of the clusters

Table 5 shows the demographic and socioeconomic characteristics of the respondents by cluster. Cluster 2 stands out in that it has the youngest members (35.2 years on average) and the highest percentage of males (81%). The educational achievement of respondents from Cluster 2 is ambiguous: While their likelihood of having no completed secondary education is the greatest among all crypto-gamblers (1.27%), they are also the most likely to have a PhD (5.06%). Despite their young age, respondents of Cluster 2 are overrepresented in the highest income classes – 2,000–2,999 EUR (31.65%), 3,000–4,999 EUR (34.18%), and >5,000 EUR (11.39%) – and almost 57% of these heavy users are married. Beside these differences, however, the comparison discloses that crypto-gamblers are a quite homogeneous group of users in terms of their socioeconomics. The heterogeneity, i.e. significant differences among the clusters, originates from the average age and knowledge levels. With reference to the latter, the self-assessed knowledge about cryptocurrency (8.37) and blockchain technology (7.85) by users of Cluster 2 far exceeds the other clusters.

Table 5. Comparison of the clusters in terms of demographics, socio-economics and self-assessed knowledge

	Full sample (1)	Cluster 1 (C1)	Cluster 2 (C2)	Cluster 3 (C3)	t-test of the difference between clusters					
					C1ΔC2	C1ΔC3	C2ΔC3	(1)ΔC1	(1)ΔC2	(1)ΔC3
Demographics										
Age	37.62	37.12	35.20	43.75		***	***			**
Male	0.76	0.71	0.81	0.78						
Education										
NSE	0.01	0.01	0.01	0.00						
GCSE eq.	0.11	0.15	0.08	0.08						
Craft training	0.09	0.13	0.05	0.05	*	*				
Comm. training	0.25	0.19	0.32	0.30	**					
A-level eq.	0.18	0.20	0.18	0.13						
Higher ed. d.	0.32	0.31	0.32	0.38						
PhD	0.04	0.02	0.05	0.08						
Income (EUR)										
< 500	0.02	0.02	0.01	0.05						
500 - 999	0.02	0.03	0.03	0.00		*				**
1,000 - 1,499	0.10	0.10	0.06	0.18						
1,500 - 1,999	0.14	0.15	0.11	0.15						
2,000 - 2,999	0.26	0.23	0.32	0.23						
3,000 - 4,999	0.35	0.35	0.34	0.35						
> 5,000	0.09	0.09	0.11	0.05						
Social Status										
Single	0.27	0.26	0.27	0.28						
Married	0.50	0.49	0.57	0.43						
Partnership	0.19	0.23	0.13	0.20	*					
Widowed	0.00	0.00	0.01	0.00						
Divorced/Sep.	0.04	0.02	0.03	0.10						
Knowledge										
Cryptocurrency	7.51	7.318	8.367	6.35	***	**	***		***	***
Blockchain tech.	6.51	6.168	7.848	4.80	***	***	***		***	***
N	226	107	79	40						

* p<.1, ** p<.05, *** p<.01 (Student's *t*-test).

4. Discussion

This study primarily sought to identify variables which differentiate users of both cryptocurrency and gambling ("crypto-gamblers") from those who only pursue either activity, as well as the socioeconomic and demographic profiles and patterns of involvement of these crypto-gamblers. With the exception of the initial investment amount and the number of coins owned, we found significant differences between the four focus groups of respondents with regard to all variables relating to cryptocurrency involvement and use. While cryptocurrency ownership is generally associated with high perceived knowledge and high levels of trust and ideology (Steinmetz et al., 2021), the present study reveals that these levels are noticeably higher for many cryptocurrency users who also gamble – which we interpret to mean that crypto-gamblers are more mentally engaged than mere crypto-users and gamblers. Arguably, the majority of these users are more susceptible to the narratives and ideology surrounding the cryptocurrency industry, which leads them not only to engage in one activity more intensely than users of a single technology but potentially to also engage in similar activities. Another aspect of the elevated mental engagement for crypto-users in general and crypto-gamblers in particular is that the mere ownership of cryptocurrency may cause cognitive biases (Haselton et al., 2015), in particular self-serving biases (Shepperd et al., 2008) and patterns of system justification (Jost et al., 2004), and that these biases are especially pronounced in crypto-gamblers. This possibility certainly warrants further investigation (cf. also Steinmetz, 2021).

The finding that measures of mental involvement in cryptocurrency can serve to differentiate crypto-gamblers from users who participate in only one of these activities extends the current knowledge on the interrelations between gambling and cryptocurrency involvement: It is not just the trading frequency (Mills & Nower, 2019) and not just trading-related involvement (Delfabbro et al., 2021) but several other aspects of cryptocurrency involvement that interrelate with gambling – a result that future research on the intersection between gambling and cryptocurrency should take into account. While Mills and Nower (2019) find that cryptocurrency trading elevates engagement in gambling, our results indicate that participation in gambling influences cryptocurrency involvement, including both mental aspects and trading.

Comparing crypto-gamblers and crypto-users who did not gamble, the frequency of use is another important differentiator of the two groups. Across all usage domains for cryptocurrency, the reported frequencies were higher for crypto-gamblers. The only non-significant differences were found for the frequencies of investment and "Other". The frequency of speculation was found to be the second-highest for crypto-gamblers after investment, which highlights the relative importance of speculating for this group and confirms the findings on the associations of gambling and cryptocurrency trading by Delfabbro et al. (2021) and Mills and Nower (2019). With regard to the frequencies reported for the different usage domains, it needs to be pointed out that cryptocurrency markets were considered "bearish" by the time of the survey. Accordingly, the frequencies reported by the respondents would assumably be higher in other market conditions and the differences found between the samples require validation by future research.

Crypto-gamblers are more involved than mere cryptocurrency users not just mentally and frequently but also financially. The average initial investment of users who gambled was 171% as large as that of non-gamblers, and the former's average crypto portfolio was almost twice as valuable as the latter's (Δ EUR 3,665.78, $p < .01$). Overall, crypto-gamblers more than doubled their investment (234%), as did the mere cryptocurrency users (204%). Despite their similar performance, the average initial investment amount by crypto-gamblers is noteworthy and indicates a higher risk-affinity. Note that this difference in investment success need not be attributable to one group's participation in gambling. Other potential explanations include diverging market conditions and the different timing of the respondents' trading. More research is clearly needed to assess the impact of gambling on crypto-portfolio performance, while also taking into account the financial backgrounds of respondents and a characterization of risk across different cryptocurrencies and portfolio constellations.

While crypto-gamblers are younger on average, more likely to be male, better educated and financially better-off than mere crypto-users, they are even more dissimilar from mere gamblers. The socioeconomic and demographic profile of the crypto-gamblers covered by this survey resembles that of gamblers of skill-based games, as well as day-traders who also gambled (Arthur & Delfabbro, 2016) and is similar to that of high-risk stock traders (Arthur et al., 2015). This finding is consistent with the results by Mills and Nower (2019), who report a negative correlation of age with cryptocurrency trading frequency, but at odds with the results by Delfabbro et al. (2021), who report a younger age of pure cryptocurrency users versus those who also gambled. These deviations, however, are comparably small and may be attributable to the other study's focus on sports betting, instead of gambling in general, to regional differences, and to panel characteristics. Our extracting the crypto-gamblers from the full sample of cryptocurrency owners has served to refine the user profiling conducted by Steinmetz et al. (2021). Furthermore, the resulting profile is based on a representative sample and thus complements current knowledge on this user group's profile through a more faceted picture of cryptocurrency involvement. However, since our sample covers only Germany, future research should verify the results for other regions.

The multivariate analysis of this study aimed to disclose patterns of involvement along the relevant variables identified in the descriptive part. The cluster analysis reveals that the subsample of crypto-gamblers comprises a heterogenous set of users who differ in terms of their mental, proactive, and financial involvement in cryptocurrency. Clusters 1 and 2 are most similar, while Clusters 2 and 3 are most dissimilar – the latter two clusters mark the extremes in terms of involvement. Users in Cluster 1 exhibit above-average ideological motivation, whereas in Cluster 3, every aspect of involvement is below the average of the crypto-gamblers. Users in Cluster 2 in turn feature such extreme levels of involvement that they considerably lift the averages. The observation that mental involvement is at its greatest for the heavy users (Cluster 2) but similarly high for Cluster 1 indicates the importance of trust and, in particular, ideology in the context of cryptocurrency for the majority of crypto-gamblers. With regard to the potential interrelations of mental involvement in cryptocurrency and the frequency of speculating, Cluster 1 is particularly interesting because it indicates that high levels of mental involvement are not necessarily accompanied by high frequencies of speculation, as opposed

to Cluster 2. This ambiguity indicates that there are undisclosed associations between mental involvement and active engagement, which, however, do not apply to all crypto-gamblers. Beyond the extensive set of variables used by Delfabbro et al. (2021) and Mills and Nower (2019), the narratives and ideologies which permeate cryptocurrency markets should play a more important role in future research on the topic. For example, future research could investigate the predictive power of the identified involvement variables for gambling participation and frequencies, or the effects of mental involvement on the activity of cryptocurrency trading and gambling.

Lastly, the results show that crypto-gamblers are at risk of becoming "over-involved" in cryptocurrency in financial, proactive or mental terms. Future research might assess more detailed aspects of gambling involvement (i.e. problem gambling severity, preferred games, frequencies of gambling) among heavy crypto-gamblers and identify those aspects that induce users of one activity to also embrace the other activity.

The results contribute to our understanding of the interrelations between cryptocurrency trading and gambling by showing that not only does cryptocurrency trading influence engagement in gambling; additionally, gambling participation influences the users' engagement in cryptocurrency beyond trading. This mutual influence between the two activities suggests that besides the structural similarity of both gambling and cryptocurrency trading, they are indeed substitutes for certain types of users. These findings are in line with conclusions by Delfabbro et al. (2021), according to which cryptocurrency traders who also gamble may approach both activities in similar ways. As our results show, such behaviors pertain not only to the context of cryptocurrency trading frequency but also to mental and financial aspects of involvement.

5. Limitations

As with any cross-sectional research, our study is subject to several limitations that relate to risks of selection bias and information bias (Wang & Cheng, 2020). Internet users who volunteer for a panel are a minority of all internet users, of whom they may not be representative. While our sample is representative of German internet users in terms of age and sex, the proportion of cryptocurrency users and gamblers it contains may be larger than the corresponding proportion among all internet users. Besides such sampling bias, the study may also be subject to information bias, e.g. in the form of observer bias or recall bias. Cross-sectional study designs have the additional drawback that the predictive power is limited because outcome and exposure variables are assessed simultaneously (Carlson & Morrison, 2009), which makes it impossible to establish true relationships of cause and effect without longitudinal data (Solem, 2015). The cross-sectional character of this study thus affects the generalizability of the results and their interpretation.

The variables covering respondents' levels of knowledge about cryptocurrency and blockchain technology, estimations of the trustworthiness of cryptocurrency as well as the strength of ideological motivation for owning cryptocurrency have certain limitations. Knowledge levels have been reported based on respondents' self-estimations which implies that they are not validated. A validated "cryptocurrency literacy" test was not available by the time of the survey.

With regard to the variable "trust", specifying different aspects of cryptocurrency in the survey would have been too domain-specific for respondents not familiar enough with the matter and would have carried the risk of receiving random answers by less knowledgeable respondents. Lastly, the variable capturing respondents' ideological motivation assesses the strength of motivations which brings the advantage of comparability with other variables in the context of our analysis, i.e. in relation to trust and knowledge, while it limits the comparability with the existing literature on specific ideologies involved in cryptocurrency ownership.

Our focus sample of cryptocurrency users who also gamble must be distinguished from people who use their cryptocurrency to gamble with decentralized gambling applications or as deposits or wagers for gambling. The questionnaire does not specify which modes or types of gambling the respondents engage in. Therefore, the findings may not be representative of this specific tech-savvy user group of gamblers using cryptocurrency in gambling applications. Generalizability is further limited by the fact that detailed information was not collected about the respondents' gambling habits (e.g. frequency), types of games (e.g. slots), and problem gambling (e.g. PGSI). In consequence, the criteria applied for qualifying as a "gambler" in the context of this analysis is simplified and requires in-depth verification by future research.

Since the cryptocurrency industry is subject to rapid innovation and constant evolvement, the used data, which was gathered in 2019, does not capture the recent and important phenomena in the industry, e.g. decentralized finance (DeFi; Werner et al., 2021), non-fungible tokens (NFT; Ante, 2022) and new market entrants who changed the competitive landscape of smart-contract-capable infrastructural blockchain projects. While the age of the used data imposes a limitation for the generalizability of this study's results, it also reveals potentials for future research to replicate the study with more recent data.

6. Conclusion

Gambling is an aspect of all financial speculation, be it trading in high-risk stocks or in cryptocurrency markets. In a departure from the existing literature on the interrelations of cryptocurrency and gambling, this study has investigated whether participation in gambling affects involvement in cryptocurrency, rather than the other way around. The results contribute to the current knowledge on the intersections of cryptocurrency trading and gambling by identifying variables which differentiate users of both activities from those participation only in either activity. The results show that besides the frequency of speculating, crypto-gamblers exhibit much greater mental and financial involvement in cryptocurrency than pure crypto-users. This implies that the intersections of trading and gambling transcend the structural similarities of wagering money with limited information and that our breakdown of cryptocurrency involvement is better suited to investigating the interrelations of cryptocurrency and gambling than mere trading frequencies.

The profiles of crypto-gamblers resemble those of skill-based gamblers and stock traders but differ in terms of their average young age. The finding that high levels of cryptocurrency involvement mostly pertain to young, well-educated, well-off and, apparently, risk-affine men can help regulators identify potential beneficiaries of protective measures. However, the fact

that a sizable share of crypto-gamblers was identified as heavy users underlines the necessity for further research on this phenomenon. This is especially pressing given the increasing prevalence of cryptocurrency and common business practices in the cryptocurrency industry that encourage users to increase their trading activities.

These observations yield three major conclusions: Firstly, over-involvement in cryptocurrency among crypto-gamblers is not limited to the frequency of speculating but also comprises, importantly, mental and, less importantly, financial aspects of involvement. Secondly, these users are likely to be especially receptive for messages which promote their levels of trust, ideological motivation and self-assessed knowledge. Thirdly, the interrelations among the investigated involvement variables suggest that high levels of mental involvement among crypto-gamblers induce higher engagement in terms of owning more cryptocurrencies and speculating more often. This in turn suggests that, similarly to gambling and high-risk stock trading, a minority of users would benefit from protective measures, whereas most users would be unduly burdened. Such measures could include restrictions on monthly frequencies or raise awareness of the users' trading activities and performance, in combination with recommendations and self-limitation systems. Resistance to any such approaches is to be expected not just from the providers but indeed from the users themselves, many of whom are purposely engaging in an activity that has so far been free of all state-intervention and censorship. Any attempt to regulate this highly innovative, dynamic, intangible and international industry will prove to be a huge challenge.

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Appendix

Table A1. Ownership rates for the top 15 cryptocurrencies in different subsamples

Cryptocurrency	Full sample	All Crypto-users	Pure Crypto-users	Crypto-gamblers
Bitcoin (BTC)	0.07	0.81	0.82	0.80
Ethereum (ETH)	0.02	0.26	0.25	0.26
Ripple (XRP)	0.01	0.15	0.12	0.17
Bitcoin Cash (BCH)	0.01	0.14	0.08	0.18
EOS (EOS)	0.00	0.04	0.05	0.03
Stellar Lumens (XLM)	0.00	0.04	0.05	0.03
Litecoin (LTC)	0.01	0.16	0.14	0.17
Tether (USDT)	0.00	0.03	0.03	0.04
Bitcoin SV (BSV)	0.00	0.04	0.03	0.04
TRON (TRX)	0.00	0.05	0.05	0.05
Cardano (ADA)	0.00	0.02	0.03	0.02
Iota (IOT)	0.01	0.07	0.08	0.06
Monero (XMR)	0.01	0.06	0.05	0.06
Binance Coin (BNB)	0.00	0.02	0.02	0.02
Dash (DASH)	0.01	0.07	0.08	0.07
N	3,864	357	131	226

The cryptocurrencies are ordered by their market capitalization at the time of the survey.

Declarations

Availability of data and materials:
The datasets used and/or analyzed during the current study are available from the corresponding author on request.

Conflicts of interest:
The author does not have any conflicts of interest to report.

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Ethical considerations:
The panel provider ensures for professional ethics and data protection. In particular, the service provider points out adherence to the General Data Protection Regulation (GDPR), European Society for Opinion and Market Research's (ESOMAR) guidelines for professional conduct as specified in the "International Code of Marketing and Social Research Practice" by the International Chamber of Commerce (ICC) and ESOMAR as well as codices by the BVM (Berufsverband Deutscher Markt- und Sozialforscher e.V.; the governing body of German market research).

About the Blockchain Research Lab

The Blockchain Research Lab promotes independent science and research on blockchain technologies and the publication of the results in the form of scientific papers and contributions to conferences and other media. The BRL is a non-profit organization aiming, on the one hand, to further the general understanding of the blockchain technology and, on the other hand, to analyze the resulting challenges and opportunities as well as their socio-economic consequences.

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