TO BUY OR NOT TO BUY CRYPTO – COGNITIVE REFLECTION, TEMPORAL DISCOUNTING, AND RISK PREFERENCE IN CRYPTO ASSETS ADOPTION

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TO BUY OR NOT TO BUY CRYPTO – COGNITIVE REFLECTION, TEMPORAL DISCOUNTING, AND RISK PREFERENCE IN CRYPTO ASSETS ADOPTION

Research in progress

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Abstract

The purpose of this research in progress is to investigate the potential impact of Cognitive Reflection Test (CRT) scores, temporal discounting, and risk preferences on crypto-assets adoption and non-adoption. This article, therefore, proposes a novel theoretical framework and hypotheses which can potentially improve the understanding of the financial behavior of crypto-assets adopters and non-adopters. Integrating the existing body of knowledge from Dual Process Theory, Theory of Discounted Utility and Prospect Theory enables us to use cognitive reflection scores, discount rates, and risk preferences as constituents of crypto-assets adopters and non-adopters. The intention of this research proposal is to test the soundness of our theoretical framework and hypotheses and to enhance our theoretical framework and hypotheses, as well as overall paper, based on the conference feedback and our initial findings in the near future.

Key words: Crypto-assets adopters; Crypto-assets non-adopters; Cognitive reflection test (CRT); Temporal discounting, Risk preferences.

1 Introduction

On the 15th of January 2022, an article appeared in Guardian with the title Trading is gambling, no doubt about it’ – how cryptocurrency dealing fuels addiction. The article briefly describes the tragic destiny of one crypto investor named Steven who was in recovery at the Castle Craig residential treatment clinic in Scotland. The article further states that at Castle Craig, where Steven is receiving treatment, the first crypto addict arrived at the clinic in 2016, followed by more than 100 since then. The article ends with the opinion of Tony Marini a senior specialist therapist at the clinic and a recovering gambling addict himself who states: More and more people are isolated and are doing this (trading), especially since Covid started. It’s tenfold already since 2016, so what’s it going to be like in the next five years?

The question that Tony Marini poses at the end of the Guardian article is very appealing and should attract the attention of IS community, broader academia, and policymakers. Hence, it is important to understand more deeply what drives people's behavior to invest in cryptocurrencies, and what are the potentially damaging effects of crypto-assets adoption on people's behavior? The answers to these questions require a much better understanding of the financial behavior of crypto-assets adopters and non-adopters. The results from the study of Mills and Nower (2019) suggest that trading cryptocurrencies may be appealing to gamblers that are exhibiting greater problem gambling severity. Further, Delfabbro et al., (2021) indicate that people who are attracted to gambling are also statistically more likely to engage in higher-risk speculation such as day-trading of stocks and cryptocurrency trading.
Published reports indicate that some people become overly preoccupied with the crypto price movements, overspend, and lose sleep over the crypto investing activity has led to the suspicion that it may be addictive for some individuals (Kim et al., 2020; Mills & Nower, 2019). Nevertheless, it would be very wrong to claim that all crypto investors are gamblers and addicted to crypto trading representing one homogeneous group. But we believe that in a market with such high volatility, where prices fluctuate so severely in such a short time, it is too hard to find some meaningful patterns to rely your investment decision on some technical financial analysis more common for stock trading. Hence, we think that the large number of crypto-adopters tend to rely more on their intuition when they buy cryptocurrencies, while at the same time they are more prepared to accept higher risks. We further want to discover the attributes of crypto-adopters who manifest highly cryptocurrency intense behavior, in terms of their CRT score, discounting rapidity, and risk preferences.

The rapid development of the crypto-assets market in terms of a high number of cryptocurrencies and market capitalization attracted the attention of investors, researchers, policymakers, and regulators. Crypto-asset attracts the attention of investors for various reasons: as a medium of exchange or to transfer funds pseudo-anonymously; as a store of wealth if agents distrust conventional money, central banks or banks; as an asset for speculation with the potential of capital gains; for illegal activities (Houben and Snyers, 2020). Moreover, people may buy cryptocurrencies with an interest in technology or new applications, with or without an economic rationale (Stix, 2021). Stix (2021) found that intentions to adopt cryptocurrencies are strongly affected by profit expectations and by beliefs that crypto assets offer advantages for payments.

Many studies before investigated the perceptions, motivations, demographics, and behaviors of crypto-assets adopters and non-adopters (Abramova and Böhme, 2016; Fujiki, 2020; Fujiki, 2021; Stix, 2021; Voskobojnikov et al., 2020; Voskobojnikov et al., 2021). No known studies evaluated the differences in CRT score, discounting functions, and risk preferences of crypto assets adopters and non-adopters. Hence, mainly through the lens of dual-process theory and temporal discounting, we intend to investigate the behavior of crypto-assets adopters and non-adopters and to identify potential significant differences between the two groups. We further explore the potential influence of CRT score, temporal discounting, and risk preference on cryptocurrency intensity behavior, within the group of crypto-adopters. This research in progress intends to test the usability of dual-process theory and temporal discounting for better understanding the financial behavior of crypto-assets adopters and non-adopters. Hence, the aim of this research in progress is to establish the theoretical ground for further research, focusing on five research questions:

1) Does CRT of crypto-assets adopters significantly differ from crypto non-adopters?
2) Does the temporal discounting of crypto-assets adopters significantly differ from crypto non-adopters?
3) Does the risk preference of crypto-assets adopters significantly differ from non-adopters in the domain of gain and losses?
4) How CRT score of crypto-assets adopters and non-adopters affect their temporal discounting and risk preference?
5) How CRT score, temporal discounting, and risk preference are related to cryptocurrency intensity behavior?

We believe that answering the above-stated research questions is important for several reasons: First, the potential significant difference in CRT score between crypto-assets adopters and non-adopters would show whether intuitive behavior plays a significant role in crypto-assets adoption. Second, determining the rapidity of temporal discounting for both groups would show whether these two groups manifest significantly different discounting functions and reward preferences. Third, investigating the risk preference for both groups in the gain and loss domain will help to better understand the risk preferences of both groups. Fourth, investigating and confirming the potential influence of CRT score on temporal discounting and risk preference would help us to more deeply understand the financial behavior of both groups. The regulatory response would be different if (most) investors deeply comprehend the risks when investing in crypto assets (Stix, 2021) and were not
intuitively motivated to enter the crypto-assets market. In the end, through answering the last research question we intend to discover whether crypto-investing may be addictive for some crypto-adopters.

2 Theoretical background

In spite of the ubiquity of cryptocurrencies as an investment option, much remains to be understood about the variables influencing cryptocurrency investment behavior. The following literature review firstly briefly summarizes the implications of the rise of the crypto-assets market. Then, the potential relation between dual-process theory, temporal discounting, risk preference, and crypto-assets adoption is explained. Finally, the theoretical framework is introduced and research hypotheses are developed based on the previous literature.

2.1 Crypto-assets market and investment implications

Along with the blockchains’ invention, the creation of cryptocurrencies brought the financial markets worldwide to a new era (Zhao and Zhang, 2021). The cryptocurrency market has experienced exponential growth in the 10 years following its inception in 2008 (Xi et al., 2020). According to Coinmarketcap in November 2021 there exist around 14,000 different crypto assets with a market capitalization of about 2.7 trillion dollars. Despite the extreme volatility in prices and the high probability of losing money a significant number of investors have considered cryptocurrencies as an investable asset class.

The adoption of cryptocurrency assets has been a great concern for policymakers and central banks in the last couple of years. Central banks are concerned that they might lose domestic monetary control if the central bank digital currency of some other economy or some privately issued stable coins circulates within its jurisdiction (Fujiki, 2021). Hence, many central banks around the world have issued or started to consider the possibility to introduce central bank digital currency. On the other hand, policymakers are concerned about a set of serious risks related to the use of cryptocurrencies in money laundering, illicit financing, and consumer and investor protection (Fujiki, 2020). The high volatility of the crypto market prices makes buying cryptocurrencies a high-risk investment bringing potential danger for heavy financial losses of many investors. Hence it is very important to investigate the actual dissemination of crypto-assets among the broad public and the financial behavior of crypto-adopters and non-adopters.

A myriad of cryptocurrencies offers distinctive features to investors making it extremely difficult for individual investors to assess the potential of each type of cryptocurrency. Hileman and Rauches (2017) consider four major categories of cryptocurrency use such as investments, medium of exchange, payment rail, and non-monetary use cases. Baur et al., (2018) indicate that cryptocurrencies can be treated similarly to stocks, bonds, and commodities and can be classified as investments. Many individuals shifted their attention toward cryptocurrencies and started to include cryptocurrencies in their portfolios (Dyhrberg, 2016). The growing awareness and enthusiasm for cryptocurrencies make understanding the determinants of cryptocurrency investment very important (Zhao and Zhang, 2021).

2.2 Dual Process Theory and Temporal Discounting

“Thinking fast and slow” was a book bestseller, published by Daniel Kahneman, the Nobel prize winner in economics that popularized widely the discoveries of dual-process theory. According to this theory, two cognitive processes (systems) exist in our mind: those executed quickly with little conscious deliberation and those that are slower and more reflective. Stanovich and West (2000) called these "System 1" and "System 2" processes, respectively (Frederick, 2005). System 1 processes occur spontaneously and do not require or consume much attention, while System 2 processes involve mental operations requiring effort, motivation, concentration, and the execution of learned rules (Frederick, 2005). Researchers believe that Cognitive Reflection Test (CRT) responses characterize the interaction between two competing mental processes as defined by dual-process theory (Kahneman, 2011; Sinayev and Peters, 2016).
Preferences and cognitive ability are fundamental determinants of decision-making in economic models (Dohmen et al., 2010). When applying the dual-process theory to understand factors determining cryptocurrency investment in this study, the cognitive factor specifically refers to biased judgment and decision making. Many studies have revealed an association between CRT and biased judgment in decision making where many of such biases were linked to System 1’s impulsive reaction (Cheng and Janssen, 2019). Investors like all other decision-makers are constantly confronted with trade-off costs and benefits at different points in time. Hence, the first goal of our study is to test whether there are proportionally significant differences in CRT levels between crypto-adopters and crypto non-adopters.

Temporal discounting tasks are often adopted to study issues of impulsive decision-making (Cheng et al., 2012). Temporal discounting is defined as a decrease in the subjective value of rewards that are available in a future time point as compared to rewards that are immediately available or that are offered in a temporally closer time interval (Berns et al., 2007). The subjective value of delayed rewards decreases as a function of the delay interval. In other words, as delay to a reward increases, the subjective value of the reward decreases (Scholten et al., 2014). Depending upon the rate at which a reward is discounted, preferences may shift in favor of smaller but more immediate rewards (Kagel et al., 1986). For example, given the choice between 500$ right now and 500$ in 12 months, most everyone would prefer to receive 500$ now. But, when the choice is between 500$ now and 650$ in 12 months, some individuals may prefer to receive the smaller reward now, rather than wait 12 months for an extra 150$. For these individuals, preference has shifted favor of a smaller, but more immediate, reward. However, researchers who study temporal discounting intend to determine the indifference point where the participant will switch from preferring the immediate reward to the delayed reward. The indifference point represents the subjective value of the reward for the participant because it is the amount preferred (which will vary by participant) and is usually less than the face value of the larger delayed reward (Critchfield & Kollins, 2001). Indifference is determined at the point when the individual no longer feels compelled to choose between the two values because the difference in reward is small and the time frame is also small (Tate et al., 2015).

The notion that more intelligent people are more patient—that they devalue or "discount" future rewards less—has prevailed for some time (Frederick, 2005). Several studies reported that in the intertemporal choice task, participants with lower CRT scores displayed a stronger preference for the immediate smaller rewards than for the later larger rewards and hence, were more impulsive in their choices (Bialek and Sawicki, 2018; Frederick, 2005; Sinayev and Peters, 2016). Fujiku (2020) found that crypto-assets adopters tend to be more impatient having higher time preferences or stronger preference for the immediate smaller reward, but in the same study, discount rates were not calculated and not compared for the two groups. Therefore, one of the aims of our study is to determine the discount rates and indifference points of crypto-assets adopters and non-adopters. This will reveal whether there are substantial differences between the two groups. Second, we would investigate how the level of CRT affects temporal discounting. It would be reasonable to expect that crypto-asset adopters with lower CRT would have higher discount rates, more rapid discounting, and a stronger preference for the immediate smaller reward.

Intertemporal or time preferences are choices between streams of outcomes differing in value and timing (Scholten et al., 2014). Following the approach of Frederick (2005), we intend to further investigate the time preferences of crypto-assets adopters and non-adopters, on two additional choices between an immediate reward and a sequence of delayed rewards and a smaller immediate loss or a larger delayed loss. Warner and Pleeter (2001) described a real-world example dilemma faced by military employees making choice between two compensation packages: a smaller one-time payment or a larger payment to be delivered in installments over an 18-year period. Most individuals in this situation preferred the immediate smaller compensation package. Also, apart from exploring time preference between the two groups in the domain of gain, it is also interesting to investigate their time preference in the domain of losses. The results would show whether the financial behavior of both
groups of crypto assets-adopters and non-adopters is significantly different when they are confronted with these choices and whether the level of CRT score plays a role in making the choices.

2.3 Cognitive Reflection Test (CRT), Risk Preference and Cryptocurrency Intensity Behaviour

Butler et al., (2013) found that enhancing reliance on intuition lowers the probability of being ambiguity averse by 30 percentage points and increases risk tolerance by about 30 percent in the experimental subpopulation. Dohmen et al., (2018) indicate that one pattern that emerges frequently is that cognitive ability tends to be positively correlated with avoidance of harmful risky situations, but it tends to be negatively correlated with risk aversion in advantageous situations. Roghanizad and Neufeld (2015) in a laboratory experiment explored how consumers evaluate website trustworthiness and found that when faced with a no-risk hypothetical decision about whether or not they would purchase a book from an online bookseller, subjects’ decision-making processes were indeed consistent with the dominant deliberative view. However, when confronted with a decision entailing risk (i.e., sharing sensitive personal information with an unknown website), subjects became reliant on their non-rational or gut feelings.

Although economists tend to find a positive association between participation in the conventional risky financial asset market and financial literacy (Lusardi and Mitchell, 2014; Gomes et al., 2021) the relationship between crypto asset ownership and financial literacy varies from country to country, and from dataset to dataset. Stix (2021) surveyed Austrian households to study ownership and purchase intentions of crypto-assets and found that on average, owners are more risk-tolerant than non-owners. Fujiki (2021) indicates that three studies have shown a negative relationship between crypto asset ownership and financial literacy (Panos, et al., 2020; Henry et al. 2020a, 2020b), while two studies have found a positive one (Stix 2021; Fujiki 2020). The inconclusive results about the relation of financial literacy and crypto-assets adoption ask for more research to investigate whether the investment decisions of crypto assets adopters may be largely driven by their inner gut feeling or intuition. Further, Delfabbro et al., (2021) indicate that people who are attracted to gambling are also statistically more likely to engage in higher-risk speculation such as day-trading of stocks and cryptocurrency trading. Research showed that gambling disorder patients discounted future rewards more steeply compared to healthy control participants (Calluso et al., 2020). Hence, the previous studies provide the theoretical background to believe that there is a potential relationship between CRT, temporal discounting, and risk preferences considering cryptocurrency investing as highly risky behavior.

To assess the relation of CRT and risk preferences of crypto-assets adopters and non-adopters we use the questionnaire of Frederick (2005), including choices between a certain gain (or loss) and some probability of a larger gain (or loss). The questionnaire maximize the expected value in some items by choosing the gamble, and for other items maximize by choosing the certain outcome. Federick, (2005) study showed that in general participants with higher CRT were more willing to gamble suggesting that the correlation between cognitive ability and risk-taking in gains is not due solely to a greater disposition to compute an expected value. On the other hand for items involving losses, the high CRT group was less risk-seeking; they were more willing to accept a sure loss to avoid playing a gamble with lower (more negative) expected value. We think that investigating the risk preferences of crypto-assets adopters and non-adopters in the domain of gain and loss would reveal valuable insights for better profiling the financial behavior of crypto-assets adopters and non-adopters.

Based on Delfabbro et al., (2021) we are going to measure the cryptocurrency intensity behavior of crypto-adopters, through measures for frequency in trading, the daily-monitoring intensity of coins value, and daily engagement in terms of how many hours per day crypto-adopters spent reading up, researching, or studying the markets. Further, we intend to discover whether CRT level, temporal discounting, and risk preferences are somehow related to cryptocurrency intensity behavior. We would like to see whether crypto-adopters who have lower CRT scores, more rapid discounting and higher risk preferences have also more intensive behavior related to cryptocurrencies.
3. Theoretical Framework and Hypotheses

The conceptual framework given in figure 1 presents the theoretical background for the development of the proposed hypotheses for testing. The theoretical framework presents the key variables that are going to be measured and compared between the two groups under investigation. We develop and propose the testing of the hypotheses based on the knowledge from three dominant theories 1) dual-process theory, 2) theory of discounted utility and 3) prospect theory. Further, within the group of crypto-adopters, we intend to measure the cryptocurrency intensity behavior in order to investigate its potential relationship with the level of CRT score, discount rates, and risk preferences.

![Diagram of Theoretical Framework](image)

**Figure 1. Theoretical framework**

The first hypothesis test whether crypto-adopters and non-adopters process information differently. To the best of our knowledge, no previous studies compared CRT scores between crypto-assets adopters and non-adopters. We believe that crypto-assets adopters and non-adopters will score significantly differently on the CRT test. Dohmen et al., (2018) found that enhancing cognitive ability tends to be positively correlated with avoidance of harmful risky situations, while Butler et al., (2013) found that reliance on intuition increases risk tolerance. Considering the volatility of the crypto market and the readiness of crypto-adopters to be involved in the very risky investment, we expect that they will tend to have proportionally lower CRT scores than non-adopters. This test will show whether crypto-adopters have predispositions toward intuitive versus reflective thinking and it will reveal whether crypto adopters tend to be dispositionally less or more reflective than non-adopters. Also, it would be very interesting to see the distribution of the CRT scores for the two groups on all 4 items and the distribution on the three potential answers 1) correct answer 2) intuitive error and 3) non-intuitive error. The distribution of answers in these three categories of answers can reveal significant insight about potential differences between the groups in their cognitive reasoning.

**H1:** There is a significant difference in CRT scores between crypto adopters and non-adopters.

The second hypothesis H2.1 test whether there is a significant difference in temporal discounting between crypto-adopters and non-adopters. We believe that crypto-assets adopters would have higher discounted rates compared to non-adopters because steeper delay discounting is associated with more impulsive behavior. Fujiku (2020) found that crypto-assets adopters tend to be more impatient having higher time preferences or stronger preference for the immediate smaller reward. Further with hypothesis H2.2, we intend to test whether these two groups have a significant difference in both variables jointly (CRT and discount rate).

**H2.1:** Crypto-adopters have higher discounting rates and more rapid temporal discounting than non-adopters.
**H2.2:** There is a significant difference in CRT score and discount rates between crypto-adopters and non-adopters.

Regarding time preference we develop two additional hypotheses H2.3 and H2.4. The aim of hypothesis H2.3 is to investigate the preferences of crypto-adopters and non-adopters regarding their choices when they are confronted with a tradeoff between choosing an immediate reward or sequence of later rewards (e.g., 500$ now or 150$ every year for 5 years). Following the rationale that crypto-assets adopters tend to be more impatient than we would expect that they would prefer the immediate smaller reward than a sequence of later rewards. Also, it would be very interesting to investigate the preferences of both groups regarding their choices related to potential losses. Considering crypto-adopters as significantly more impatient with a stronger preference for immediate rewards and wellbeing we may expect that they will show a significantly higher preference for later larger losses than for the smaller immediate loss.

**H2.3:** Crypto-adopters have a higher preference for immediate reward than for a sequence of delayed rewards compared to crypto non-adopters.

**H2.4:** Crypto-adopters have a higher preference for later larger loss than for a smaller immediate loss compared to crypto non-adopters.

We further intend to test the risk preferences of crypto-adopters and non-adopters with hypotheses H3.1-H3.4. We would expect that crypto-adopters will show a preference for higher risk when they are confronted with gamble choices. Following the method of Frederick (2005) we intend to test the financial behavior of crypto-adopters and non-adopters when they are confronted with three potential choices between

1) certain gain or higher expected value gambles (e.g., $1,000 for sure or a 90% chance of $5,000)
2) certain gain or lower expected value gambles (e.g., $100 for sure or a 25% chance of $200) and
3) certain loss or lower expected value gambles (e.g., lose $10 for sure or a 90% chance to lose $50)

**H3.1:** Crypto-adopters have higher risk preference than crypto non-adopters when they are confronted with certain gain or higher expected value gambles.

**H3.2:** Crypto-adopters have higher risk preference than crypto non-adopters when they are confronted with certain gain or lower expected value gambles.

In general, we would expect that crypto-adopters will show higher risk preference and be more willing to gamble than crypto non-adopters. But according to the prospect theory, people will be more willing to take risks to avoid losses than to achieve gains; respondents will switch from risk aversion to risk-seeking when the valence of a gamble (or “prospect”) changes from positive to negative (Kahneman and Tversky, 1979). The same theory is stating that one will make different decisions under different conditions, namely during the gain or the loss. For example, when investors are within the gain domain, they tend to have a lower risk-taking behavior when they are confronted with avoiding losses from investors that are in the loss domain. Consistent with the prospect theory, we developed the two hypotheses H3.3 and H3.4. We are very keen to find out whether the crypto adopters will still show significantly stronger orientation towards gambling from non-adopters in case of avoiding losses. We believe that they will manifest a stronger preference for higher risk because the crypto market is a highly volatile and risky market meaning that attracts highly risky investors prepared for heavy financial losses. With the H3.4 hypothesis, we further intend to investigate the potential difference in risk preference within the group of crypto-adopters when they are confronted with loss aversion. To test H3.4 we intend to collect data from crypto-adopters whether they are at the moment of filling the survey in the gain or loss domain from buying cryptocurrencies.
H3.3: Crypto-adopters will have a higher risk preference than crypto-non adopters when they are confronted with avoiding losses.

H3.4: Crypto-adopters in the gain domain will have a lower risk preference than crypto-adopters in the loss domain when they are confronted with avoiding losses.

To answer our fourth research question we are going to investigate the relationship between the CRT score, temporal discounting, and risk preference in both groups. We intend to investigate the differences in discount rates and risk preferences between crypto-adopters and non-adopters who scored high on CRT score (high/high). Also, we are going to test the differences in discount rates and risk preferences between crypto-adopters and non-adopters who scored low on CRT score (low/low). For that purpose, we are going to make two groups with high/high and two groups with low/low CRT scores. A Series of studies (Bialek and Sawicki, 2018; Frederick, 2005; Sinayev and Peters 2016) found that participants with lower CRT scores displayed a stronger preference for immediate lower rewards. Further, it is reasonable to expect that crypto-adopters with high CRT scores would have a higher level of risk preferences than non-adopters with high CRT scores respectively. We expect the same tendency to hold also for crypto-adopters with low CRT scores when the two groups are compared. Hence we propose the following hypotheses for testing.

H4.1: Crypto-adopters with high/low CRT scores will tend to have significantly more rapid temporal discounting than non-adopters with high/low CRT scores.

H4.2: Crypto-adopters with high/low CRT scores will tend to have significantly higher risk preferences than crypto-non adopters with high/low CRT scores.

H4.3: Crypto-adopters with high/low CRT scores will tend to have significantly higher risk preferences to avoid losses than crypto-non adopters with high/low CRT scores.

Research showed that day-traders were significantly more likely than non-day-traders to engage in gambling activities and in recent years, this perspective has also been applied to cryptocurrency trading (Delfabbro 2021). We intend to use three measures from the study of Delfabbro et al., (2021) to measure the intensity of crypto-currency behavior 1) trading frequency 2) daily monitoring intensity, and daily engagement. Some of this behavior has been likened to a form of gambling because the behavior appears impulsive, short-term-focused, and risky (Delfabbro et al., 2021). Hence, we intend to investigate how CRT score, discount rates, and risk preferences are related to cryptocurrency intensity behavior. We would expect that the crypto adopters who have lower CRT scores, higher discount rates, and higher risk preferences are more prone to manifest higher intensity of crypto-currency behavior. Hence we developed the following hypotheses.

H5.1: Crypto-adopters that have high CRT scores have lower cryptocurrency intensity behavior on all three dimensions than crypto-adopters with low CRT scores.

H5.2: Crypto-adopters with higher discounting rates have higher cryptocurrency intensity behavior on all three dimensions than crypto-adopters with lower discount rates.

H5.3: Crypto-adopters with higher risk preferences have higher cryptocurrency intensity behavior on all three dimensions than crypto-adopters with lower risk preferences.

In the end, we would like to test whether there is a potential relationship between the CRT score, temporal discounting, risk preference, and amount of money invested in the crypto market. We think that crypto-adopters with lower CRT scores, higher discount rates, and higher risk preferences may tend to invest a larger amount of money in the crypto market. Hence we propose the following hypothesis for testing.

H5.4: Crypto-adopters who invested a larger sum of money in the crypto-market tend to have a significant difference in CRT score, discount rates, and risk preferences, compared to the smaller crypto investors.
4 Data Collection and Measuring Instrument

We intend to conduct an online survey in order to collect the data and to examine and test the proposed research hypotheses. In order to test the established hypotheses, we need to make a distinction between two groups of crypto-assets adopters and non-adopters. The survey instrument would include a self-reported option about ownership and awareness of crypto-assets with the following options:

1) I own crypto assets
2) I owned crypto assets
3) I never owned crypto-assets
4) I never owned, but I am interested in crypto assets
5) I know of only by name, but have absolutely no interest
6) Never heard of crypto-assets.

All respondents who will choose option 1 or 2 will be classified as crypto-adopters, while the rest who choose options 3, 4, or 5 will be classified as non-adopters. Those who opt for option 6 will be discarded from the sample. Cryptocurrency usage domains are mostly condensed to usage as a means of payment or as an investment (Steinmetz et al., 2021). Stix (2021) found that intentions to adopt cryptocurrencies are strongly affected by profit expectations and by beliefs that crypto-assets offer advantages for payments, while distrust in banks or in conventional currencies is not found to be an important driver of ownership. We intend to include an item in the survey instrument that will collect data related to the motives for cryptocurrency ownership, but we believe that dominant motives for ownership are mainly profit expectations and payment. The dominant motives for crypto-adoptions are in line with the proposed hypotheses and our intention to test the potential relationship between CRT, temporal discounting, and risk preference for crypto-adopters and non-adopters. Fujiku (2020) found that crypto-owners are more likely to be male, aged below 30 years, have higher pretax income, work in private or public companies, or be self-employed, and be graduate-school graduates compared with nonowners. Hence we are going to collect some key demographic data from the survey about gender, age, level of education, money invested on crypto-market, wealth (low net wealth, middle net wealth and high net wealth) and income level of the participants in order to test for controls and ensure greater validity in hypothesis testing. The categories for wealth and money invested from participants are going to be adjusted with the real economic conditions within the country where data are going to be collected.

Following the approach of other studies (Cheng and Jenssen, 2019; Sinayev and Peters, 2015) CRT will be measured through four measuring items. To clarify the impact of the intuitive error on decision preference we adopted two kinds of scoring criteria where the first one differentiates the incorrect and correct answers, while the second also teased apart the errors into two categories: intuitive errors and other errors. The items and the scoring keys are listed below.

1. If you’re running a race and you pass the person in second place, what place are you in? (intuitive answer: first; correct answer: second).
2. A farmer had 15 sheep and all but 8 died. How many are left? (intuitive answer: 7; correct answer: 8).
3. Emily’s father has three daughters. The first two are named April and May. What is the third daughter’s name? (intuitive answer: June; correct answer: Emily)
4. How many cubic feet of dirt are there in a hole that is 3’ deep x 3’ wide x 3’ long? (intuitive answer: 27; correct answer: none)

For measuring temporal discounting we intend to use Kirby delay-discounting Monetary Choice Questionnaire (MCQ) which has 27-items that measure temporal discounting rates (Chabris et al., 2010). The MCQ is a 27-item questionnaire that measures temporal discounting rates, and it is one of the best-validated discount rate measures (Duckworth et al., 2005; Kirby, 2009). We intend to adjust
the monetary values in the questionnaire by multiplying all monetary values with 10 with the intention to make the monetary values in the questionnaire appealing more realistic and closer to crypto-adopters today taking into consideration the average amount today invested in the crypto-market.

Kirby Delay-Discounting Questionnaire is an efficient method for obtaining estimates of discounting and one of the advantages of the questionnaire is that it enables the collection of delay discounting data from large samples within a short time and at a low cost, which is useful when the emphasis of the study is not on the individual but rather on obtaining an epidemiological profile of delay discounting (Matta et al., 2012).

Based on the data collected through MCQ we are going to calculate two measures: the area under the curve (AUC) and the k parameter following the Kirby et al. (1999) methods. The k-parameter shows whether the individual is less or more sensitive to delay meaning that when the value of k is small, the individual is less sensitive to delay, and shows less discounting in response to delay. Thus higher values of k are indicative of high levels of impulsivity. Using the value of the smaller immediate reward (SIR) and larger delayed reward (LDR), and the delay, we are going to calculate the value of k (discounting rate) by the yield indifference between the SIR and LDR. Within reward-size categories, we intend to use Mazur (1987) equation to solve k: k = ((LDR / SIR) − 1) / Delay. To calculate AUC we are going to plot the indifference point values obtained at various delays, with value plotted on the y-axis and delay on the x-axis. We think that hyperbolic discounting that allows for dynamic inconsistency is much descriptively superior to exponential discounting (Cheng and González-Vallejo, 2016). Hyperbolic discounting is more closer to what humans do (crypto-adopters and non-adopters) meaning that the further people look into the future, the lower their discount rate is.

We intend to use the measuring items from the questionnaire used in the study of Frederick (2005) to further investigate the time preference and risk preference of crypto-adopters and non-adopters. Apart from temporal discounting, we are going to investigate the time preference of crypto-assets adopters and non-adopters on the two additional choices between an immediate reward and a sequence of delayed rewards (e.g., 400$ now or 100$ every year for 10 years) and a smaller immediate loss or a larger delayed loss (loose 1000$ this year or loose 2000$ next year). Also, we are going to use the items from the questionnaire of Frederick (2005) to investigate three choices related to risk preferences

1) certain gains vs. higher expected value gambles (e.g., $1,000 for sure or a 90% chance of $5,000)
2) certain gains vs. lower expected value gambles (100 for sure or a 25% chance of $200) and
3) certain losses vs. lower expected value gambles ( lose $100 for sure or a 75% chance to lose $200).

To measure the cryptocurrency intensity behavior in the cripto-adopters group we intend to use the following measuring items from the study of Delfabbro et al., (2021)

1) To measure the trading frequency - How often they had traded cryptocurrency on a 6-point scale: 1 = Less than monthly, 2 = about once per month, 3 = 2–3 times per month, 4 = Weekly, 5 = 3–6 times per week and 6 = Daily
2) To measure daily monitoring intensity - How often during a trading day they checked the coin prices: Never or not daily; 1–3 times; Hourly at least; Every few minutes.
3) To measure daily engagement (duration measure) - How many hours per day they spent reading up, researching, studying or studying the crypto market.

For this research study, we have estimated the right sample size for testing the proposed hypotheses by using the tables offered by Israel (1992). The estimated population of crypto-adopters for North Macedonia is 20,000 according to the triple-A website (https://triple-a.io/crypto-ownership/, visited on 03/20/2022), while the number of crypto-non adopters is larger than 100,000 because the population of North Macedonia where we intend to conduct the survey is around 1.8 million. Israel (1992) suggest that for a confidence level of 95% and a standard error of alpha of 0.05, a population of 20,000, the right sample size is 392. For the same confidence level and standard error for a population larger than
100,000, the right sample size is 400. Because in our study we compare crypto-adopters and non-adopters we will need a total sample size with a minimum of 792 respondents.

To test the formulated hypotheses firstly we are going to conduct the Shapiro-Wilk test to verify whether residuals are normally distributed and whether the normality assumption stands. If the normality is not violated a parametric t-test will be used for testing the hypotheses H1 and H2.1. If the normality assumption is violated, then we intend to use a non-parametric test such as the Wilcoxon Signed-Rank test. Further to test hypothesis H2.2 we intend to use MANOVA because this hypothesis includes the testing relationship between one categorical independent variable and multiple dependent variables. For the rest of the formulated hypotheses H2.3, H2.4, and H3.1, H3.2, H3.3, and H3.4 we are going to use chi-square because both independent and dependent variables are categorical. Further to test the hypotheses H4.1, H4.2 and H4.3 we are going to create two groups with high and low CRT scores within each group of crypto-adopters and non-adopters based on the value of the CRT. All crypto-adopters and non-adopters who have answered correctly 2 and less than two questions on the CRT test would be classified in the low CRT group, while the rest who have correctly answered 3 or 4 questions in the CRT test will be classified as high CRT group. We intend to use a parametric t-test to test H4.1 because this hypothesis tests the difference in mean values between two groups with one dependent variable. To test H4.2 and H4.3 we are going to use the chi-square test because these hypotheses test the difference between two dependent dichotomous variables.

For the testing of the final hypotheses H5.1, H5.2 and H5.3 we are going to use as dependent variables the three dimensions of cryptocurrency intensity behavior and we are going to perform separate three tests for each dimension. Trading frequency and monitoring intensity are dependent and ordinal variables and therefore we are going to use the Wilcoxon Signed-Rank test to test H5.1 and H5.2 when these two dimensions are used as measures for cryptocurrency intensity behavior as dependent variables. When the third dimension daily engagement is used as a measure for cryptocurrency intensity behavior we intend to use the t-test because this variable is a continuous variable. At the end to test H5.4, we are going to create three groups of crypto-adopters based on the level of their money invested in the crypto market (small, medium, and large money investments). Then we will test whether there are significant differences between the three groups in CRT score and discount rates with the t-test while differences in risk preferences will be tested separately with the chi-square test.

4 Next steps of the Research

This research-in-progress reports on the development of a theoretical framework and derived hypotheses, that will be further examined and tested. In this study, we basically tried to identify promising research variables or constructs, to better explain the investment behavior of crypto-assets adopters and non-adopters. Figure 2 illustrates the completed steps as part of the research in progress and future plans that will be conducted to complete the research process.

![Research process diagram]

Figure 2. Research process

The research process remains incomplete because we first wanted to test the soundness of our theoretical framework and established hypotheses through the communication of the research ideas with the broader research community in information systems. We are planning to enhance our theoretical framework and hypotheses, as well as overall paper, based on the conference feedbacks and our initial findings in the near future.
References


