The effect of financial literacy and positive feedback on investment behaviour in Bitcoin markets





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Abstract

The welfare loss of not participating in the stock market can be sizable. For Bitcoin investments, the relation is not so simple. There is no clear consensus in the literature, whether investors should invest in Bitcoin. There is evidence that Bitcoin is often in bubbles, but also that it provides excellent diversification possibilities. The problem that arises is that participants in Bitcoin markets are usually new to investing. These new investors do not know how to diversify their portfolio well and take too many risks when investing. The first contribution we make is showing that there is no significant effect of financial literacy on the investment amount in Bitcoin is often in bubbles. Feedback trading is that investors buy assets when prices rise and sell when prices drop. The second contribution we make is showing that the amount of euro's that participants invest in Bitcoin is not significantly affected by positive feedback. The third contribution we make is showing that there is no compound effect of financial literacy and positive feedback on how much individuals invest in Bitcoin.

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1. Introduction

Bitcoin was introduced in the aftermath of the financial crisis of 2008 when there was distrust in the financial system. The focus of the creator of Bitcoin was to improve what the general public considered weak points of a centralized banking system (Nakamoto, 2008). Today, Bitcoin is one, if not the most widespread used cryptocurrency in the world. In the past decade, the amount of Bitcoin users and trading volume increased tremendously. The sharp rises in prices create opportunities for investors to make large gains in short periods. This news about people getting rich quick attracted a lot of new investors which led to the excessive growth of Bitcoin.

Bouri, Gupta & Roubaud (2019) find that these new Bitcoin users are often inexperienced investors. That is problematic because unsophisticated investors often mimic the behaviour of other investors which leads to herd behaviour. Herd behaviour leads to inefficiencies and systematic risk in Bitcoin markets what concerns policymakers (Panos & Karkkainen, 2020). Moreover, unsophisticated investors often do not diversify their portfolio, which leads to unsystematic risk. Financial literacy is essential to equip people to make informed financial decisions in today's society, where there are a lot of investment vehicles available to the public (Klapper, Lusardi & Van Oudheusden, 2015). Past studies on the relationship between financial literacy and Bitcoin find that financial literacy has a negative effect on the probability of currently owning Bitcoin. The first contribution that this paper makes to the literature is investigating whether the invested amount in Bitcoin is higher in an experimental setting. We allocated an experimental endowment of €10,000 to our participants. We find a statistically insignificant result that financially literate individuals invest €722 more in the Bitcoin than financially illiterate participants.

In classic economic theory, stocks prices equal the discounted value of all future cash flows (Harrison & Kreps, 1978). Research shows that behavioural anomalies affect investors' choices in financial markets (Silva, Neto & Klotzle, 2019). However, there is always some turning point that pushes prices in the direction of fundamentals (Long, Shleiffer, Summers & Waldmann, 1989). Cheah & Fry (2015) find that the fundamental value of Bitcoin is zero. When investors buy an asset with the sole reason of selling it back later, they create speculative behaviour in asset markets (Harrison & Kreps, 1978). Baek & Elbeck (2015) find speculative behaviour Bitcoin markets and are worried (Baek & Elbeck, 2015). Positive feedback traders buy assets when prices rise and sell when prices drop (Long et al., 1989). Some rational speculators bet on the short-run future direction of the market if they expect that prices drive away from fundamentals. This behaviour leads to a lot of noise in the market and can ultimately lead to the forming of bubbles. There is robust empiric evidence that in the past, there have been bubbles in Bitcoin markets (Shu & Zhu, 2020; Cheah & Fry, 2015). The second contribution that this paper makes to the existing literature is investigating whether positive feedback leads to a higher invested amount in Bitcoin. We find a statistically insignificant result that individuals invest €688 more in Bitcoin when receiving positive than when receiving negative feedback.

The third contribution that this paper makes to the existing literature is investigating whether there is a compound effect of financial literacy and receiving positive feedback. We investigated this by creating an interaction term that checks whether there is a statistical difference in the invested amount when an individual is financially literate and received positive feedback. We find that individuals who are in the positive feedback treatment and are financially literate invest €2037 more in the Bitcoin, but this is statistically insignificant, so we can not prove that there is a relationship.

2. Literature review

This chapter aims to give an extensive overview of the literature available on investment behaviour in Bitcoin markets. In section 2.1, this paper will address what Bitcoin is, how it anticipated on the financial crisis in 2008, and how it could grow so quickly. Section 2.2 analyzes what kind of investment vehicle Bitcoin is. We compare Bitcoin to well-known investment vehicles like currencies, stocks and gold. Then, in section 2.3, this paper gives an overview of the effect of financial literacy and participating in investing. In section 2.4, we discuss whether there are bubbles in Bitcoin markets. Finally, in section 2.5, we formulate the hypotheses used in this paper.

2.1. The rise of Bitcoin

Bitcoin is a decentralized peer to peer network. The creators of Bitcoin are unknown, although many refer to Satoshi Nakamoto as one of the creators. The blockchain records every single transaction in a public list. This record makes it possible to trace the history of the cryptocurrency to stop people from spending coins they do not own, making copies or undo-ing transactions (Nakamota, 2008).

Nakamoto (2008) invented Bitcoin in the financial crisis of 2008 anticipating on the fact that there was a lot of distrust in the financial system. The focus of Nakamoto (2008) was on improving what the general public considered weak points of a centralized banking system.

The first point of improvement is the fact that there is no need for intervention of traditional banks and institutions. In this decentralized peer-to-peer network, payments are sent directly from one party to the other. This network improved privacy and reduced transaction costs. Second, no authority or issuer dominates the market (Reid & Harrigan, 2012). The mining of Bitcoins is the process that generates Bitcoin. This process creates a predictable growth rate of the supply. A predictable rate of supply means certainty about how many coins are in circulation (Rogojanu & Badea, 2014). This predictable supply is an attractive characteristic because this means that there is no direct monetary policy that can influence the number of coins in circulation. This predictability takes away the uncertainty

that requested in markets after the financial crisis of 2008. There is no unexpected increase in the supply of the coin, which leads to more certainty (Burghelea, 2008).

2.2. Bitcoin and traditional investment vehicles

2.2.1. Comparing Bitcoin and traditional currencies

The goal of Nakamoto was to create a currency that overcomes the problems accompanied with traditional currencies. Traditional currencies are standard economic goods that are priced by the interaction of supply and demand on the market. This section will now elaborate on whether Bitcoin should be considered a currency. According to Yermack (2013), economists define a currency by having three attributes: it functions as a medium of exchange, a unit of account, and a store of value.

You could argue that Bitcoin meets the first attribute, because a growing number of merchants, especially in online markets, are willing to accept Bitcoin as a form of payment (Chuen 2015; Yermack, 2015). On the contrary, the actual commercial use of Bitcoin remains minuscule compared to its market capitalization (Yermack, 2015).

The second attribute is the unit of account. The two criteria for this are: the price of the product is easily interpretable, and prices of products are stable. First, easily interpretable prices are important because consumers and producers want to be able to compare the prices of goods. Bitcoin does not fulfil this criterion, because most goods are priced 4 or 5 decimals behind the zero. Second, stable prices of products are essential, because consumes and suppliers have to deal with a high spread on goods otherwise (Dwyer, 2015).

The third attribute is the store of value, that is that a currency remains its value without depreciating. Store of value is essential because owners of currency want certainty about the economic value in the future. First, the predictable rate of supply of Bitcoin means certainty about how many coins there are in circulation (Rogajanu & Badea, 2014). Purely based on a predictable rate of supply, you would expect a steady price, but in reality, there is a lot of volatility in Bitcoin markets. Second, Bitcoin trades at different prices at different exchanges which is the result of limited arbitrage opportunities (Yermack, 2015). Third, the encrypted system of Bitcoin is secure; however, there have been significant hacks in Bitcoin exchanges in recent years. The most prominent example of this is the hack of the Bitcoin exchange Mt Gox where 750,000 Bitcoins, were stolen with a \$400 million value at the time (Trautman,

2014). Fourthly, Bitcoin is useless as a hedging instrument for currency risk, because Bitcoin exhibits virtually zero correlation with major currencies like the yen, euro and British pound (Yermack, 2015).

Bitcoin has some similarities to currencies, like being a medium of exchange for some transactions, that make you intuitively think that it is similar to a traditional currency. Dyhrberg (2016) finds that Bitcoin reacts significantly to the federal funds rate, which points to Bitcoin as a currency. On the contrary, Dyhrberg (2016) argues that because Bitcoin is decentralized and unregulated, it will never indeed behave like a currency. Additionally, as discussed before, Bitcoin lacks additional characteristics that are usually associated with currencies. The actual commercial use is minuscule, comparing prices of goods is hard, and it is too volatile for it to be a traditional currency (Yermack, 2015; Weber, 2016).

2.2.2. A comparison between Bitcoin and stock investments

Market participants in Bitcoin markets often refer to it as an investment. Therefore it is interesting to investigate the similarities and differences of Bitcoin and stocks. In standard economic theory, a common stock that pays dividends will price at the discounted value of all of the expected future cash flows (Harrison & Kreps, 1978, p. 323). This standard theory is too simplistic to give an overview of what the stock market is like in the real world. The stock market is sometimes overvalued or undervalued because of speculators and noise traders that drive prices away from fundamentals. However, there is always some turning point that pushes prices in the direction of fundamentals (Long et al., 1989).

First, the standard economic theory of Harrison & Kreps (1978) cannot explain why Bitcoin is so expensive. In Bitcoin markets, there are no cash flows paid to owners of the asset, like there are in stock markets, so the only way to cash out is to sell your Bitcoin to another market participant. Second, there are more noise traders in Bitcoin markets than in the stock market, which makes the market more volatile than the stock market. Sometimes, this even leads to bubbles in the pricing of Bitcoin (Shu & Zhu, 2020). Baek & Elbeck (2015) found that Bitcoin is 26 times more volatile than the S&P 500. Third, Kristoufek (2013) finds that Bitcoin is detached finds from the real economy because its price is not affected by macro-economic factors. The price formation cannot be explained theories, such as future cash-flows model, purchasing power parity or uncovered interest rate parity. Baek & Elbeck (2015) complement the research of Kristoufek (2013) by finding that the market participants are the primary determinant of the price of Bitcoin. When Bitcoin usage increases, it is expected that volatility drops and that its price will be determined more by macroeconomic variables. This would lead to a more internally and externally balanced investment vehicle (Baek & Elbeck, 2015).

There are some similarities between the Bitcoin and the stock market. However, the fact that there are no fundamentals in Bitcoin markets makes the two assets very different. That Bitcoin is not similar to stock does not immediately mean that it is useless as an asset. Baur Hong & Lee (2018) find that the return properties of Bitcoin are very different from traditional assets and stocks. This provides excellent diversification opportunities for investors. However, investors should be very cautious with adding Bitcoin to their portfolio because it can be found in bubbles often (Baek & Elbeck, 2015).

2.2.3. Bitcoin as an alternative to gold

This section gives an overview of the similarities between Bitcoin and gold. First, we compare the characteristics of the two assets. Second, the behaviour of the assets is compared by reviewing the available literature on the topic.

The first characteristic is that the supply of gold is limited because mining is expensive, and there is not much out there to be found in nature, which makes it a scarce good. Second, people have been using gold as a store of value for ages. It has a mysterious appeal that has attracted people for generations. The value may have fluctuated, but it has been one, if not the most, constant asset that always had and always will have value. The fact that gold can be used to make jewellery gives it an intrinsic value that helps with having a constant value (Schoenberger, 2011).

First, Bitcoin has a current supply of 18.5 million out of the 21 million Bitcoins available. The scarcity is one of the critical factors that drive the price of Bitcoin to such high prices. Second, Bitcoin does not have a long history of being a store of value for ages. Bitcoin will have to prove itself on this point in the future. The fact that all Bitcoins will be mined up in 2140 does not help with the continuance of the system. This would mean that the incentive would be lost for miners to secure the Bitcoin system would be gone. On the contrary, miners can still be paid for the transaction. Thus the system will still be supported; on the downside, this will mean that transaction will become very expensive (Hurlburt & Bojanova, 2014). Now the behaviour of Bitcoin compared to gold as a financial instrument will be analyzed. Dyhrberg (2016) finds that Bitcoin has similarities to gold and the dollar. Their analysis shows that Bitcoin has similarities to both the Bitcoin and the dollar. Most aspects of gold are similar to the Bitcoin because they have similar hedging capabilities and react symmetrically to good and bad news. Risk-averse investors can use its hedging capabilities in the case of bad news for the market. Therefore Dyhrberg (2016) concludes that Bitcoin has a unique position in the market since it can be used as a store of value and a medium of exchange.

Klein, Thu & Walther (2018) show that the two assets are similar in the aspect of volatility and different in the part of market linkages. The volatility of Bitcoin goes up when the price goes up and vice versa, just like the volatility of gold. However, considering the extreme price increases observed for Bitcoin, this finding is not surprising. Contrary to the result of Dyhrberg (2016), Klein et al. (2018) find that Bitcoin and gold behave differently from the perspective of market linkages. This is particularly the case in times of market distress. Due to the fact that Bitcoin shows a positive relationship to the stock market, they argue that it cannot be used as a hedging instrument against stock investments.

2.3. Financial literacy

Understanding basic financial concepts is essential to equip people well to make informed financial decisions regarding saving, investing, borrowing and more. Financial knowledge is fundamental in today's time, where an increasing number of complex financial products is available to a wide range of the population. For example, governments of several countries are pushing to boost access to financial services for the general public (Klapper et al., 2015).

With financial ignorance comes substantial costs. Consumers who fail to understand basic financial concepts spend more on transaction fees, have more significant debts and incur higher interest rates on loans (Lusardi & Tufano, 2015). They also borrow more and end up saving less money (Stango & Zinman, 2009). There are multiple potential benefits of financial literacy. Financial skills have a positive effect on planning and saving for retirement (Behrman, Mitchell, Soo & Bravo, 2012). Moreover, financially literate investors are more likely to diversify risk by spreading funds across several investments (Abreu & Mendes, 2010). Financial literacy and financial knowledge are both human capital. Both terms are often used interchangeably in the media. Financial knowledge is an essential element of financial literacy, but it is not equivalent. For an individual to be financially literate, you have to be one step further. Financial literacy has an additional application dimension which implies that an individual must have the ability to use his/her financial knowledge to make financial decisions. Measurement methods of financial literacy should not only measure whether an individual knows the information, but also if he/she can appropriately apply it (Huston, 2010).

The most crucial factor that influences the level of financial literacy of individuals is financial education. It is essential to take into account that individuals can use tools to support them in making financial decisions. For example, if an individual is struggling with arithmetic skills, he/she can use a calculator or computer software to overcome this issue. Therefore to measure financial literacy, it is more appropriate to focus on skills in navigating through personal finance than only numeracy skills (Huston, 2010).

Financial literacy is a component of human capital that is useful to increase economic well-being. Examples of other elements that affect financial well-being and financial behaviour are behavioural/cognitive biases, self-control problems and family. That a person is financially literate does not necessarily mean that this individual exhibits predicted behaviours or increases in financial-well-being because of other influences (Huston, 2010).

There are differences in how widespread financial literacy is among specific demographic factors. Financial literacy differs in for the following demographic characteristics: gender, the level of education, income and wage (Klapper et al., 2015). Worldwide, 35 per cent of men versus 30 per cent are financially literate (Lusardi & Mitchell, 2014). This gender gap is found in both advanced and emerging economies. In developed economies, financial literacy usually increases with age, and then at 50, decrease with age (Klapper et al., 2015).

2.3.1. The effect of financial literacy on stock market participation

According to Van Rooij, Lusardi & Allessie (2011), there is a lack of understanding of economics and finance in the Netherlands. The welfare loss of not-participating in the stock market can be sizable. It is still a puzzle why so only so few households hold stocks

(Campbell, 2006). Haliassos & Bertraut (1995) offer some explanations of why so many families do not own stocks. That is short-sale constraints, income risk, inertia and departures from expected utility maximization. Another cause is that young people cannot borrow and thus do not have wealth to invest in stocks (Constantinides, Donaldson & Mehra, 2002). Other reasons why so few households invest in stocks are trust and culture (Guiso, Sapienza & Zingales, 2008), the influence of neighbours and peers (Hong, Kubik & Stein, 2004) and limited numeracy (Christelis, Jappelli & Padula, 2010). However, even these reasons cannot fully explain for the lack of ownership of stocks of households (Van Rooij et al., 2011).

Stock market participation increases strongly with wealth, income levels and higher education levels. Still, the large majority of people with a university degree do not own stocks. Also, not all people with a university degree are financially literate. This fact suggests that levels of schooling are not always a good proxy for financial literacy (Van Rooij et al., 2011).

Stock market participation is present in different levels of financial literacy. Even in the basic level of financial literacy, stock market participation is found. However, stock market participation increases with every level of financial literacy. The relationship becomes the strongest when considering advanced financial literacy (Van Rooij, Lusardi & Alessie, 2011).

2.3.2. The effect of financial literacy on participation in Bitcoin markets

The paper of Panos & Karkkainen (2019) has investigated the effect of financial literacy on participation in Bitcoin markets. The main finding is that financial literacy has a negative effect on the probability of currently owning cryptocurrency. To come to this conclusion, they have designed three subcategories in their research. First, they find that the effect on now owning cryptocurrency is negative. Second, the financially literate are more likely not to intend owning cryptocurrencies. Third, the financially literate are more likely to not intend owning cryptocurrencies in the future and are more likely to have heard about cryptocurrencies and be aware of what they are. Additionally, they find that individuals who are risk-seeking are more likely to invest in the Bitcoin.

For a market to price efficiently, there has to be a combination of informed investors and speculators. This combination is crucial for newly established alternative markets that are available for the public, as the Bitcoin market. The prices in new alternative markets are often far from their fundamentals. These markets are an even more significant risk to illiterate investors because these investors do not understand the risks they are taking. An example of this is that some financially illiterate market participants finance their demand with borrowing. In some cases, this could even endanger financial stability for their household in the case of a Bitcoin crash (Panos & Karkkainen, 2019).

Regulators are concerned about the danger that comes with risky investments and the risks that unsophisticated investors take. Unsophisticated investors drive cryptocurrency markets. The behaviour of these investors causes a lot of noise. Luckily, this is becoming more important on the global agenda of financial literacy enhancement (Foley, Karlsen & Putniņš, 2019).

2.4. Speculative behaviour in asset markets 2.4.1. Bubbles in asset markets

Stocks are priced at the discounted value of all the expected future cash flows in a traditional stock market. Besides that, ownership of a stock is not only the future stream of dividends but also the right to sell that dividend stream in the future. It is most likely that investors are not content with their initial investments forever. In this case, the investors will start trading. An investor may buy the stock now even though it is overpriced, with the sole reason of selling it back later for even more to another investor. This is where speculative behaviour is created. The potential speculative profit will be reflected in the current price. Generally speaking, investors exhibit speculative behaviour when the right to resell a stock makes them willing to pay more than when they were obliged to hold it forever (Harrison & Kreps, 1978).

According to Shiller (2014), speculative bubbles are characterized by a social epidemic, that is the spread of ideas, messages through a population the same way viruses spread. This is the result of imperfect news media and information channels. History is full of examples of people who have gambled and lost during economic booms (Reinhart & Rogoff, 2009).

The literature makes a distinction between bubbles that arise from rational and from irrational behaviour (Dale, Johnson & Tang, 2005). There is evidence that rational speculation is accompanied by mass hysteria (Zeira, 1999). Rational bubbles arise when investors believe

they can sell the asset off for a higher price in the future (Flood & Hodrick, 1990). Investors require compensation in the form of higher returns for the fact that they know that the bubble will burst at some point. As the bubble grows, investors require increasing returns for the higher probability of a price collapse. This leads to strong price increases which in the end leads to the bubble bursting (Dale et al., 2005).

Within the rational bubbles framework, Dale et al. (2005) make a distinction between the intrinsic rational bubble and the extrinsic rational bubble. The intrinsic bubble occurs when investors systematically and persistently misprice fundamentals of assets (Froot & Obstfeld, 1989). This usually happens in periods of rapid innovation, when investors find it hard to determine the fundamental values of assets. The prices rise for an extended period and then crash (Zeira, 1999). Froot and Obstfeld (1989) suggest that intrinsic rational bubbles are created when there is an overreaction on the good news of dividends. Extrinsic rational bubbles occur when otherwise rational investors face uncertainty about their environment. The investors falsely applicate these uncertain external factors which have no impact on the fundamental value of the asset. When investors widely share these beliefs, this may result in asset prices deviating from fundamental values. The fact that prices adjust to forecasts of investors who do not hold superior supports the theory for the existence of extrinsic bubbles (Dale et al., 2005).

Irrational bubbles are formed when investors use psychological factors unrelated to the fundamental value of the asset to determine its value or follow market trends (Weber, 2016). First, psychological factors lead to unrealistic expectations of future profitability of investments. As a result, prices drive away from fundamental value. Second, when investors are uncertain where the market should go, some simply follow market trends. When they use market trends in their decision process on fundament values, herd behaviour is created. This herd behaviour will create a vicious circle where positive feedback leads to approval of the beliefs of the irrational investors.

2.4.2. Bubbles in Bitcoin markets

The ultimate goal of the literature on speculative bubbles in Bitcoin markets is to identify them in time, limit their size and minimize their damages when bursting. This can be done by effectively warning people for the risks associated with investing in Bitcoin. Since the release of the Bitcoin in 2009, the price of Bitcoin has gone through various price rollercoasters. The high volatility and the and rapid transition between rocking up and down poses a challenge to predict the bubbles in Bitcoin markets accurately. With the booming cryptocurrency market, the formation of bubbles and their drastic bursts could impact the lives of a lot of people across the globe (Shu & Zhu, 2020).

Shu & Zhu (2020) consider sharp price drops of over 15% within three weeks of Bitcoin crashes. The observed amount of crashes from 2011 to 2019 is 51. The duration of the crash and the time gap between crashes is usually very short. In more than half of these crashes, the Bitcoin decreased 25% in price. Even though there are a lot of crashes that correct the price, the long timescale bubble is still being blown up (Shu & Zhu, 2020).

Cheah & Fry (2015) found that there are speculative bubbles in Bitcoin markets. The results show a bubble in the Bitcoin market in the crash of December 2013. The size of the bubble was 49% of the observed price. This is a substantial size which is considered a quite severe bubble. Further, the fundamental value of Bitcoin is zero. This is because, during the bubble, prices rose so dramatically, that the estimated long-term fundamental value is not different from zero.

In stock markets, there is always a fundamental value that the asset can return to. Moreover, a sign of speculative behaviour in asset markets is when investors buy with the sole reason of selling it back later for more to another investor (Harrison & Kreps, 1978). The fact that the right to resell is a critical element in Bitcoin markets because there is no future cash flow is worrying (Baek & Elbeck, 2015). Cheah & Fry (2015) address concerns for the long-term viability of Bitcoin.

2.4.3. The effect of positive feedback theory on the formation of bubbles

Research has shown that behavioural anomalies affect investors' choices in financial markets. One element of this is positive feedback trading where investors use past data to make investment decisions. This behaviour is one of the aspects that can lead a bubble to blow up in a market (Silva, Neto & Klotzle, 2019)

In standard economic theory, the answer to what effect rational speculators have on asset prices is that rational speculators must stabilize asset prices. Speculators who destabilize asset prices buy when prices are high and sell when prices are low. Such speculators would go bankrupt quickly and would be eliminated from the market. Speculators who earn positive profit do so by betting against prices that are moved away from fundamental prices and counter them. These speculators will stabilize prices (Friedman, 1953).

In the three decades following the publishing of the paper of Friedman (1953), this argument has been generally accepted by the literature. Risk aversion of rational speculators keeps them from taking large arbitrary positions, and therefore noise traders can affect prices. Rational speculators dampen noise price movements but do not eliminate them (Long, Shleiffer, Summers & Waldmann, 1989).

The Long et al. (1989) published a paper that assesses an empirically important exception of the theory of Friedman (1953). Positive feedback investors buy securities when prices rise and sell when prices drop. Rational speculators bet on the short-run future direction of the market if they expect prices to go away from fundamentals. It pays rational speculators to jump on the bandwagon rather than to counter the trend when they expect prices to not go to their fundamentals value. For example, when rational speculators buy expecting a price increase, the price increases and positive feedback investors react to the price movement and increase the price even further. As a result, prices move away further from fundamentals because of the speculation of rational speculators. On the other hand, when rational speculators activate the positive feedback strategies of other investors, it can lead to prices moving to fundamentals (Long et al., 1989).

According to Silva, Neto & Klotzle (2019), understanding of the behaviour of feedback trading in digital markets has become essential, because this has a positive effect on price fluctuations. This leads to a lot of noise in the market and can, in the end, lead to the forming of bubbles. There is evidence that there is positive feedback trading in Bitcoin markets. The news of highs and success in the media leads to periods of great optimism and thus rises in the Bitcoin price.

2.5. Hypothesis

This research investigates factors that affect the invested amount in Bitcoin. The existing literature shows that financial literacy has a negative effect on the probability of owning cryptocurrency (Panos & Karkkainen, 2019). Regulators are concerned about the risks that financially illiterate investors take when investing in cryptocurrency. They do not understand the risks they're taking when investing, which is very dangerous (Foley et al., 2019). This

research tests whether the relationship between the invested amount in Bitcoin and the financial literacy level of participants is positively related with the following hypothesis:

H1: Financially literate individuals invest less in the Bitcoin than financially illiterate individuals.

It is found in the existing literature that there is positive feedback trading in Bitcoin markets (Silva, Neto & Klotzle, 2019). The understanding of feedback trading in Bitcoin markets has become important. The noise that these traders create causes higher volatility which can ultimately lead to the forming of bubbles (Foley et al., 2019). This research tests whether the relationship between the investment amount in Bitcoin and feedback is positive with the following hypothesis:

H2: Individuals invest more in positive feedback treatment than in the negative feedback treatment.

Phanos and Karkkainen (2019) find that higher financial literacy negatively affects the probability of owning cryptocurrency (Panos & Karkkainen, 2019) and that positive feedback ultimately leads to the forming of bubbles (Foley et al., 2019). It would be useful to know whether financially literate individuals are less influenced by positive feedback. Policymakers could use this finding by improving financial education to reduce the risk of individuals engaging in too risky Bitcoin investments and reduce the risk of bubbles. To test whether improving education would be useful, we construct the following hypothesis.

H3: financially literate participants who are in the positive feedback treatment invest less in the Bitcoin than participants who are either financially illiterate or in the negative treatment, or both.

3. Data

3.1. Data sample

To collect our data, we designed an experiment using the experimental software Qualtrics. The exact wording of the questions that we used is in the Appendix. We started the experiment with a short explanation about what cryptocurrency is and why it is valuable.

Then, we explained to the participants about the investment decisions that they are going to make. Every participant receives an experiment endowment of $\notin 10,000$ per month for five months. They are free to allocate their endowment between a risky investment in Bitcoin and putting the money in the bank for 0.5% interest. Participants make investment decisions on the first day of the month, and we pay them on the last day of the month.

The information that participants have available to inform them about the investment vehicle they are investing in is the price development of the last month. In the first investment decision, all participants receive precisely the same set of information. From the second investment decision, we split the group of participants between two treatment groups. The positive feedback treatment group experiences the rally that Bitcoin was in from March till July 2019. The negative feedback treatment experiences precisely the same, but with daily returns mirrored, and thus decreasing prices.

3.2. Variables

The dependent variable is the amount of euro's that the participants invest in the Bitcoin in the experiment. Participants could allocate their experimental endowment of \in 10,000 per investment decision by sliding a bar to either choice option. We took an average of the invested amounts for the regressions for the sake of simplicity.

The independent variable financial literacy represents the level of financial sophistication of the participant. Van Rooij et al. (2011) compute the financial literacy score of a representative sample of the Dutch population using a basic module and an advanced module. We expected our sample to be relatively financially literate, and thus five questions of the advanced module are picked. The questions cover topics such as the difference between stocks and bonds, the function of the stock market and the relationship between bond prices

and interest rates. For every question that participants answer correctly, we add one point to their score. We created a binary dummy variable that is one if someone is financially literate and zero if someone is financially illiterate.

Treatment represents whether a participant received positive or negative feedback on their investment decisions. We used a binary dummy to indicate whether someone received positive or negative feedback. We use treatment as an independent variable in the two regression equations which we introduce in the next chapter.

To control for factors affecting the invested amount in Bitcoin, we use the following variables. First, the control variable risk profile represents the appetite for risk of participants. We compute this by using the method of Valentine (2012). Their paper uses a total of twelve questions to assess the risk profile of a participant. According to Valentine (2012), insignificant answers can be omitted without significantly reducing the explanatory power of the equation. Thus, to ensure the shortest possible questionnaire, and reduce dropout risk, the three most significant questions have been used in this paper.

We coded the risk profile of the participant as follows:

SCORE = -1 conservative behaviour = 0 neutral (balanced) behaviour = +1 growth investor

We used a binary dummy in the regression considering individuals with a score of +1 and above risk seeking and a score of 0 or below risk averse. We used a binary dummy variable instead of a categorical variable because of the distribution of risk profile and for the sake of simplicity. Other control variables we controlled for are financial background, invested in BTC before and the vector for demographic variables age and gender.

For the second regression in the following chapter, we introduce an interaction term for financial literacy * treatment that compounds the effect of these two variables. The interaction term takes value one for participant i if he/she is financially literate and is in the treatment group, that is both financial literacy and treatment have a value of one for this participant i. Similarly, if either one of the two independent variables takes value zero for participant i, then the interaction term is equal to zero.

3.3. Descriptive statistics

Table 1 presents the descriptive statistics for all of the variables in this research. Eighty-eight participants took part in this experiment. The invested amount in Bitcoin in the positive feedback treatment is relatively constant over all of the investment decisions. The invested amount in the negative treatment decreases over the first four investment decisions from 48% to 31% and rebounds a bit in the fifth investment decision to 34%. The average invested amount in the positive treatment is 44% and in the negative treatment 37%. By using a regression, we find in the results that this is not statistically different.

Table 1: Descriptive statistics				
Investment decisions [%]	Total	Positive	Negative	
Decision 1	46	45	48	
Decision 2	45	46	44	
Decision 3	43	43	43	
Decision 4	37	43	31	
Decision 5	37	45	34	
Average of decision 1-5	41	44	37	
Number of participants	88	46	42	
Understanding of investment task [%]		Financial l	iteracy [%]	
Score of 2	91	Score of 5 ((literate)	40
Score of 1	9	Score of 4 ((illiterate)	42
Score of 0	0	Score of 3 ((illiterate)	13
Gender [%]		Score of 2 (illiterate)		4
Male	77	Score of 1 (illiterate)		1
Female	23	23 Score of 0 (illiterate)		0
		Treatment	[%]	
Risk profile [%]		Positive fee	edback	52
Score of 1 (risk seeking)	38	Negative feedback		48
Score of 0 (risk averse)	55	Financial background [%]		
Score of -1 (risk averse)	7	Yes		41
		No		59
		Invested in	BTC before	
		[%]		
		Yes		25
		No		75

The score on the understanding of the investment task was 91% for the maximum score 2 and 9% for a score of 1. Because all participants had at least one question correct, we have assumed that no one randomly clicked through the experiment. In the financial literacy test, 40% of the participants scored the maximum score of 5, and 60% scored a score of 4 or lower. Participants with a score of 5 are considered financially literate, and participants with a score of 4 or lower are considered financially illiterate. We decided to use a binary dummy variable for financial literacy because 82% of the scores are either four or five. The participants are equally distributed in Qualtrics between treatments by the software. It looks like some

participants dropped out in the negative treatment because there are four more participants in the positive treatment. The maximum score (risk seeking) of 3 that participants could get on the risk profile test is 3. The minimum score that participants could get is -3 (risk averse). We observe that thirty-eight participants had a score of 1, fifty-five had a score of 0 and seven had a score of -1. Because of this uneven distribution of the scores, we decided to use a binary dummy variable that takes 1 (risk seeking) if someone has a score of 1 and takes 0 (risk averse) if someone has a score of 0 or -1.

3.4. Testing the variables

To estimate the models that will we describe in the following chapter, we use OLS estimation technique while assuming that all its assumptions are satisfied. More specifically, we firstly assume that the observations are randomly selected from the population, and thus that the sample is normally distributed. Secondly, we test for multicollinearity by using a Pearson correlation coefficients matrix. Multicollinearity occurs when an independent variable is a linear function of one or more other independent variables in the dataset. When using the Pearson test multicollinearity becomes an issue when the correlation coefficient is excessively high. Most researchers use 0.80 as the arbitrary number, and thus we will use this as well. The highest correlation is 0.6 with the variables Financial literacy and the interaction term financial literacy * treatment; therefore, we assume that there is no multicollinearity.

ge Gender FL*
Treat
0
4 1.000
0.128 1.000
<u> </u>

Table 2:	Correlation	matrix
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Thirdly, we assume that the variance of the error term is not constant for all observation, and thus that there is no heteroscedasticity. Finally, we assume that the independent variable is not correlated with the error term, that is, that there is no endogeneity.

4. Methodology

Our goal in this research is to determine the effects of different factors, such as financial literacy, risk profile of the investor, or type of feedback the investor receives, on the amount that an investor is willing to invest in Bitcoin. Taking the average of all investment decisions spread across multiple periods has been done for the sake of simplicity. This simplicity is one of the benefits of cross-sectional data over panel data, where various observations are followed over multiple periods.

To test hypothesis 1 & 2, we analyze the impact of different factors, mentioned earlier, on the invested amount in Bitcoin, we use ordinary least squares regression for the estimation of the parameters of interest in the following econometric equation:

Equation (A)

$$Y_{i} = \beta_{0} + \beta_{1}FL_{i} + \beta_{2}Treat_{i} + \beta_{3}RP_{i} + \beta_{4}FB_{i} + \beta_{5}InvBTCBef_{i} + \gamma D_{i} + u_{i}$$

Where Y_i represents the dependent variable of the model, which in our case is the amount invested in Bitcoin by the participant i. On the right-hand side of the equation, β_0 represents the constant term of the regression. Furthermore, FL_i represents the financial literacy of the observation i, **Treat**_i is a binary dummy variable describing whether user i was in the treatment group or not, that is whether he or she received a positive or negative feedback. RP_i describes the Risk Profile of the participant. Moreover, FB_i is the independent variable for Financial background, $InvBTCBef_i$ is a dummy independent variable indicating whether the observation i has invested in Bitcoin before or not. Furthermore, D_i is a vector of demographical variables such as gender or age of the participant i, that are used as control variables in our model. Additionally, β_1 measures the effect of financial literacy on the amount invested in Bitcoin, β_2 measures the effect of being in the positive feedback treatment on the amount invested in Bitcoin, β_3 measures the effect of the risk profile of the investor on the amount invested in Bitcoin. Moreover, β_4 measures the effect of having a financial background on the amount invested in Bitcoin, β_5 measures the effect of having invested in Bitcoin before on the amount invested in the experiment. γ is a vector of coefficients corresponding to the demographic variables that we use as control variables in the model. Finally, u_i represents the error term of the observation i.

To test hypothesis 3, which is about the compound effect of financial literacy and getting positive feedback, we need to add an interaction term to the model, which will be the product of the independent variable FL_i and $Treat_i$. For this purpose, we introduce an updated version of previous econometric equation that contains the interaction term which will help us to determine the impact of positive feedback (being in the treatment) when the user is financially literate versus financially illiterate. Econometric equation corresponding to this updated model is described as follows:

Equation (B)

$$Y_{i} = \beta_{0} + \beta_{1}FL_{i} + \beta_{2}Treat_{i} + \beta_{3}RP_{i} + \beta_{4}FB_{i} + \beta_{5}InvBef_{i} + \beta_{6}FL_{i} * Treat_{i} + \gamma D_{i} + u_{i}$$

Where all the parameters and variables have the same interpretation except for the parameters β_1 , β_2 and the additional interaction term that is an extra independent variable with its corresponding coefficient β_6 . In this model, β_1 measures the impact of financial literacy of observation i on the amount invested in Bitcoin when he or she was not in the treatment group (observation i received negative feedback). Moreover, β_2 measures the impact of the treatment (observation i received positive feedback) on the amount invested in Bitcoin, when this participant is financially illiterate. Finally, β_6 measures the compound effect of receiving positive feedback and being financially literature. To estimate the models described by the two equations earlier, we use OLS estimation technique while assuming that all its assumptions are satisfied.

5. Results

In this section, we will discuss the empirical results based on the regression analysis we performed. To test the first two hypotheses that we discussed at the end of chapter two, we conducted the OLS regression corresponding to equation A. The first hypothesis is that *financially literate individuals invest less in the Bitcoin than financially illiterate individuals*. Table 3 presents the OLS estimation results corresponding to equation A where we have regressed the amount of invested in Bitcoin on financial literacy, risk profile, treatment, financial background, invested in BTC before, age and gender. From these results, we observe that the coefficient corresponding to financial literacy is positive, indicating that, ceteris paribus, financially illiterate investors will invest around €722 more in Bitcoin than someone who is financially illiterate. However, the corresponding p-value is very large, suggesting that the coefficient is statistically insignificant and financial literacy does not have a statistically significant impact of the investment amount in Bitcoin, and thus we can reject the hypothesis.

The second hypothesis is that *individuals invest more in the positive feedback treatment than in the negative feedback treatment*. The coefficient corresponding to the treatment dummy indicates that if two individuals have precisely the same characteristics mentioned in this model, only one is in the positive feedback group. At the same time, the other one receives negative feedback; the former will invest €688 higher in Bitcoin compared to the latter one. The corresponding p-value here is insignificant, so we can conclude there is no effect of the positive feedback treatment on the invested amount in Bitcoin, and therefore we reject the hypothesis.

Moreover, from the same table, we observe that the coefficient corresponding to risk profile is a large positive number, implying that a risk seeking person, ceteris paribus, will invest €1408 more in Bitcoin compared to someone who is risk averse. The p-value corresponding to this coefficient is 0.02, indicating it is statistically significant at a 5% significance level. Hence, the risk profile has a statistically significant positive impact on the amount invested in Bitcoin.

The negative coefficient of financial background suggests that an individual with a financial background invests 1185 less in Bitcoin compared to the person with no financial background, ceteris paribus. From table 3, we can see that the p-value corresponding to this variable is insignificant and thus that there is no effect of financial background on the amount

invested in Bitcoin. From this table, we can also observe that the coefficient corresponding to the invested in BTC before is positive. This coefficient indicates that someone who invested in the BTC before is likely to invest €727 more compared to someone who has not invested in Bitcoin before, ceteris paribus. However, the p-value of this coefficient statistically insignificant, so whether someone has invested before in Bitcoin or not, has no significant impact on an amount invested in it.

	Equation A	Equation B	
Table 3: regressions	Invested amount BTC	Invested amount BTC	
Financial literacy	722	-330	
	(667)	(878)	
Treatment	687	-132	
	(567)	(720)	
Risk profile	1408**	1438**	
1.	(599)	(591)	
Financial background	-1185	-1123	
C	(668)	(659)	
Invested in BTC before	727	594	
	(675)	(670)	
Age	-173	-196	
-	(675)	(665)	
Gender	611	493	
	(732)	(725)	
FL * Treatment	2037		
	(1125)		
Constant	1758	2503	
	(1568)	(1600)	
Observations	88	88	
R-squared	0.1105	0.1459	
Number of investment decisions	5	5	

Standard errors in parentheses

* p < 0.05, ** p < 0.01, *** p < 0.001

Robustness checks. This table reports the relationship between the invested amount in the Bitcoin and the independent variables. The coefficient corresponds to the absolute amount that participants invested in Bitcoin. Between brackets is the absolute standard deviation.

We observe that the coefficient of the demographical variables age is negative, while the coefficient corresponding to gender is positive. In the lower part of table 3, demographical variables age and gender can be found. The corresponding coefficient for age is negative. This suggests that an individual who is older will likely invest $\in 173$ less in Bitcoin compared to someone who is younger but has precisely the same characteristics. We also observe that a man is likely to invest $\notin 611$ more compared to a woman, ceteris paribus. The p-value corresponding to both of these coefficients are statistically insignificant, and thus age nor gender have a significant impact on the amount invested in Bitcoin. To test hypothesis 3, that *financially literate participants who are in the positive feedback treatment invest less in the Bitcoin than participants who are either financially illiterate or in the negative treatment, or both* we conducted the OLS corresponding to equation B. The results of this regression are shown in table 3. We have regressed the amount invested in Bitcoin on the same set of independent variables mentioned earlier. However, in this equation, we have included an interaction term between financial literacy and positive feedback treatment, the financial literacy and treatment dummy. We observe that all the coefficients corresponding to variables not related to financial literacy and treatment have approximately the same values as in the previous estimation results. Therefore, we will interpret the coefficients corresponding to financial literacy, treatment and the interaction term between these two variables only.

From the negative coefficient corresponding to financial literacy, we observe that ceteris paribus, financially literate individuals who are in the negative feedback treatment, will invest around \in 330 less in Bitcoin. However, the corresponding p-value is statistically insignificant. Moreover, from the negative coefficient corresponding to treatment, we observe that ceteris paribus, financially illiterate individuals in the positive feedback treatment, will invest \in 132 less in the Bitcoin. The corresponding p-value is insignificant, and thus the relationship is insignificant. Finally, from the coefficient corresponding to the interaction term between financial literacy and treatment, we can see that someone who is financially literate and receives the positive treatment, will invest \in 2037 more in Bitcoin. The corresponding p-value here is insignificant, and thus we reject hypothesis 3.

6. Conclusion and discussion6.1. Conclusion

This study examines the role of financial literacy, positive feedback and the compound effect of financial literacy and positive feedback on the invested amount in Bitcoin in an experimental setting. Previous research finds that financial literacy exerts a statistically significant negative impact on the probability of owning Bitcoin. The importance of financial literacy cannot be overemphasized. Financial literacy has a clear public good element to it and is often conceptually linked to macroeconomic stability. Financially illiterate participants are less aware of the risks that come with investing in Bitcoin. Taking these risks leads to noise which makes the market even more unstable. Regulators are concerned about the risks that unsophisticated investors take and the fact that they often finance their demand with borrowing (Panos & Karkkainen, 2019). The first contribution that this paper makes to the existing literature is testing whether financially literate individuals invest less in the Bitcoin than financially illiterate individuals. This study finds that the coefficient of financial literacy is \notin 722, which suggests that financially literacy individuals invest more in the Bitcoin than financially illiterate individuals. However, the corresponding p-value is insignificant, and thus we can reject the hypothesis and conclude that the level of financial literacy does not have an effect on the amount invested in Bitcoin.

According to Silva et al. (2019), understanding of feedback trading in digital markets has become important, because this has a positive effect on volatility. The news of highs and success in the media leads to periods of great optimism and rises in the Bitcoin price, which ultimately lead to the forming of bubbles. Shu & Zhu (2020) find that there have been 51 Bitcoin crashes from 2011 to 2019. These bursts of the more considerable bubble help correcting the price, but the long timescale bubble is still being blown up. Moreover, Cheah & Fry (2015) find that there was a bubble in the Bitcoin market crash of December 2013. They argue that the fundamental value of the Bitcoin is zero. The fact that most Bitcoin investors invest in the Bitcoin with the sole reason of selling it back later for more is worrying (Baek & Elbeck, 2015). Foley et al. (2019) find that the noise that these positive feedback traders create can ultimately lead to the forming of bubbles. It would be interesting to investigate what drives these bubbles. The second contribution that this paper makes to the existing literature is investigating *whether positive feedback affects the invested amount in Bitcoin*. This is relevant because positive feedback trading is proven to drive prices away from fundamentals (Long et al., 1989). We find that the coefficient corresponding to the treatment dummy is \in 688, which suggests that individuals in the positive feedback treatment invest more in the Bitcoin. However, the corresponding p-value is insignificant, and thus we can reject the hypothesis because there is no statistical evidence of that positive feedback affects the investment amount.

Additionally, we find that the control variable of risk profile is statistically significant at the 5% level. The coefficient of risk profile is €1408, which indicates that someone who is risk seeking invests €1408 more in the Bitcoin than someone who is risk averse. The control variables financial background, invested in Bitcoin before and the vector for demographical variables are insignificant. Thus we can conclude that these do not affect the invested amount in Bitcoin.

Above we discussed that previous literature finds that financial literacy has a negative effect on the probability of owning cryptocurrency (Panos & Karkkainen, 2019) and that positive feedback ultimately leads to the forming of bubbles (Foley et al., 2019). The third contribution that this paper makes to the existing literature is that we test whether these two variables have a compound effect on the invested amount in Bitcoin. To assess the this the following hypothesis has been formulated: *financially literate participants who are in the positive feedback treatment invest less in the Bitcoin than participants who are either financially illiterate or in the negative treatment, or both*. By creating an interaction term between financial literacy and treatment, we have been able to test the hypothesis. We observe that the coefficient of this interaction term is $\notin 2037$, which suggests that financially literate individuals in the positive treatment invest more in the Bitcoin than the other participants. This is an interesting finding because we expected that the coefficient would be negative. However, the relationship is statistically insignificant, and thus, we can reject the hypothesis.

6.2. Discussion

This study and its methodology have some limitations, which represent opportunities for future research. The external validity of the experiment can be questioned. First, there were no funds available for this research, and thus there is no incentive for participants to behave optimally. Second, the average score on the financial literacy test is substantially higher than

the score of the general Dutch population. The result of a representative sample of the Dutch population was 50% correct versus a score of 83% in this experiment. Third, the regressions in our paper treated the data as cross-sectional data for the sake of simplicity. The problem with this is that you expect residuals to be random, which could cause clusters, but they are not because investors make five investment decisions. Future research should treat the data as panel data because the investment decisions happen at different points in time. Fourth, for the variables risk profile and age, we used a binary dummy variable, for the sake of simplicity and, because there were not enough observations to use categorical variables.

This paper finds no significant effect of the treatments on the invested amount in Bitcoin. Silva et al. (2019) found that there is positive feedback trading in Bitcoin markets. First, we would like to recommend future researchers to start the treatment in investment decision 1 instead of 2. That way, more investment decisions are treated, and that will generate more relevant results. Second, the investment amount in the positive treatment was relatively constant over the investment decisions. The investment amount in the negative treatment went down, and then up in the end. The disposition effect is the anomaly that investors sell winners too early and ride losers too long (Shefrin & Statman, 1985). It would be interesting to see in future research whether there is a disposition in Bitcoin markets.

Regulators are concerned about the danger that comes with risky investments and the risks that unsophisticated investors take. Furthermore, the cryptocurrency market is driven by unsophisticated investors that cause a lot of noise (Foley et al., 2019). Financially literate investors are more likely to diversify risk by spreading funds across several investments (Abreu & Mendes, 2010). The participants in this research all had a relatively high financial literacy compared to the general Dutch population in the study of Van Rooij et al. (2011). Thus, we should critically whether the participants in this research who are considered financially illiterate are indeed financially illiterate.

This research did find an insignificant result for the compound effect of being financially literate and being in the positive feedback treatment. The expectation was to see a negative effect, but the coefficient was €2037, which indicates that the compound effect of financial literacy and the positive feedback treatment. Long et al. (1989) finds that it pays rational speculators to jump on the bandwagon instead of countering the trend. Whether this is the case in Bitcoin markets cannot be proven in this research, but it would be an exciting topic for future research.

7. References

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8. Appendix

Survey introduction

Dear participant,

Welcome! In this experiment, you will be offered hypothetical investment opportunities. You do not need financial knowledge to answer these questions.

First a few questions will test your knowledge of investing. For the experiment part there are no right or wrong answers.

This survey will be processed anonymously and takes around ten minutes.

Financial literacy test

- 1. Which of the following statements describes the main function of the stock market?
 - (i) The stock market helps to predict stock earnings.
 - (ii) The stock market results in an increase in the price of stocks.
 - (iii) The stock market brings people who want to buy stocks together with those who want to sell stocks.
- 2. Which of the following statements is correct? If somebody buys the stock of firm A in the stock market:
 - (i) He owns a part of firm A.
 - (ii) He has lent money to firm A.
 - (iii) He is liable for firm A's debts.
- 3. Which of the following statements is correct? If somebody buys a bond of firm B:
 - (i) He owns a part of firm B.
 - (ii) He has lent money to firm B.
 - (iii) He is liable for firm B's debts.
- 4. If the interest rate on savings falls, what should happen to bond prices?
 - (i) Rise.
 - (ii) Fall.
 - (iii) Stay the same.
- 5. Which of the following statements is correct?
 - (i) Once one invests in a mutual fund, one cannot withdraw the money in the first year.
 - (ii) Mutual funds can invest in several assets, for example invest in both stocks and bonds.
 - (iii) Mutual funds pay a guaranteed rate of return which depends on their past performance.

Bitcoin investment decision

First I will explain shortly what a cryptocurrency is. Then I will give you a short investment task where you can decide between a risky cryptocurrency investment and a safe investment (putting your money) risk free in the bank for 0.5% interest.

What is a cryptocurrency?

The cryptocurrency is a digital medium of exchange – a type of money that is completely virtual. Every single transaction is recorded in a public list called the blockchain. This makes it possible to trace the history of the cryptocurrency to stop people from spending coins they do not own, making copies or undo-ing transactions.

In order for the cryptocurrency's system to work, people offer computer power to process transactions for everybody. People who do this are called "miners". The miners get a small reward in the cryptocurrency every time the computer solves such a puzzle. The puzzles are becoming more and more difficult to prevent too much of the cryptocurrency being generated. So far, 18.5 million out of a total 21 million coins have been generated.

Even though it is called cryptocurrency, it does not show similarities to the typical aspects of a traditional currency like the euro. For example, most people use the cryptocurrency as an investment rather than daily payment method. It is not similar to stocks either: stocks pay you dividends when the company makes profit and the cryptocurrency pays you nothing.

Why is the cryptocurrency valuable?

The cryptocurrency is considered valuable by some people because it is a rare good like gold and diamonds. Also, there are people that like the fact that it is not controlled by a government and that it is anonymous. The people that use the cryptocurrency usually trade it for cash.

Assignment

Assume you will receive 10,000 euro the first day of each of the upcoming 5 months. You will invest the 10,000 euro you receive every month for 1 month. When the month is over you will receive the payment. There are two options. The first option is to invest your money in a risky cryptocurrency. The second option is that you put your money risk free on the bank for 0.5% interest per year. You are free to decide how much you want to invest in each one.

How much of your first $\notin 10,000$ do you want to invest in the cryptocurrency? The more you slide to the right the more you invest in the cryptocurrency and the rest you put risk free in the bank for 0.5% interest.

Below you find a graph that shows the price development of (last month) February. Your investment will start on the first of March and you will receive your payout at the end of

March. This is investment 1/5. The more you slide to the right, the more you invest in the cryptocurrency.



Positive feedback treatment

Investment last month

Below you can find two graphs. Graph 1 shows the price development of last month. The % that is in graph 1 is the profit or loss you have made on the cryptocurrency investment last month. Graph 2 shows the total price development of the cryptocurrency. The risk free investment of putting your money in the bank made 0.04% (1/12 of 0.5%).

Assignment upcoming month

You have the same two options as last time. The first option is to invest your money in the same risky cryptocurrency investment for the next month. The second option is that you put your money risk free on the bank for 0.5% interest per year for the next month. You are free to decide how much you want to invest in each one.

How much of your $\in 10,000$ do you want to invest in the cryptocurrency? The more you slide to the right the more you invest in the cryptocurrency and the rest you invest you will put in the bank for 0.5% interest per year.

Price cryptocurrency March (8% increase) € 3.800.00 € 3.600,00 . e 3.400,00 € 3.200,00 17 1, 11 19 19 19 Date 03 19 19 € 3.000,00 03:12:19 03-07-19 03-09-19 03-13-19 03-21-19 0323-19 03-15-19 03.01-19 03.03.19 03.05-19 03-15-19 03:21:19 03-20-Price cryptocurrency total development (21% increase February - March) € 3.700.00 € 3.500.00 € 3.300.00 € 3.100.00 € 2.900,00 € 2.700,00 € 2.500,00 02.01.19 02.08-19 03:22:19 03-29-19 0222 03:08 Date 1000 3000 4000 5000 6000 8000 9000

This is monthly investment 2/5.

Investment amount in cryptocurrency on 1st of April till 30th of April.

Below you can find two graphs. Graph 1 shows the price development of last month. The % that is in graph 1 is the profit or loss you have made on the cryptocurrency investment last month. Graph 2 shows the total price development of the cryptocurrency. The risk free investment of putting your money in the bank made 0.04% (1/12 of 0.5%).

Assignment upcoming month (same information as last investment)

You have the same two options as last time. The first option is to invest your money in the same risky cryptocurrency investment for the next month. The second option is that you put your money risk free on the bank for 0.5% interest per year for the next month. You are free to decide how much you want to invest in each one.

How much of your $\in 10,000$ do you want to invest in the cryptocurrency? The more you slide to the right the more you invest in the cryptocurrency and the rest you invest you will put in the bank for 0.5% interest per year.



This is monthly investment 3/5

Below you can find two graphs. Graph 1 shows the price development of last month. The % that is in graph 1 is the profit or loss you have made on the cryptocurrency investment last month. Graph 2 shows the total price development of the cryptocurrency. The risk free investment of putting your money in the bank made 0.04% (1/12 of 0.5%).

Assignment upcoming month (same information as last investment)

You have the same two options as last time. The first option is to invest your money in the same risky cryptocurrency investment for the next month. The second option is that you put your money risk free on the bank for 0.5% interest per year for the next month. You are free to decide how much you want to invest in each one.

How much of your $\in 10,000$ do you want to invest in the cryptocurrency? The more you slide to the right the more you invest in the cryptocurrency and the rest you invest you will put in the bank for 0.5% interest per year.



This is monthly investment 4/5

Below you can find two graphs. Graph 1 shows the price development of last month. The % that is in graph 1 is the profit or loss you have made on the cryptocurrency investment last month. Graph 2 shows the total price development of the cryptocurrency. The risk free investment of putting your money in the bank made 0.04% (1/12 of 0.5%).

Assignment upcoming month (same information as last investment)

You have the same two options as last time. The first option is to invest your money in the same risky cryptocurrency investment for the next month. The second option is that you put your money risk free on the bank for 0.5% interest per year for the next month. You are free to decide how much you want to invest in each one.

How much of your $\in 10,000$ do you want to invest in the cryptocurrency? The more you slide to the right the more you invest in the cryptocurrency and the rest you invest you will put in the bank for 0.5% interest per year.



This is monthly investment 5/5

Negative feedback treatment

Investment last month

Below you can find two graphs. Graph 1 shows the price development of last month. The % that is in graph 1 is the profit or loss you have made on the cryptocurrency investment last month. Graph 2 shows the total price development of the cryptocurrency. The risk free investment of putting your money in the bank made 0.04% (1/12 of 0.5%).

Assignment upcoming month

You have the same two options as last time. The first option is to invest your money in the same risky cryptocurrency investment for the next month. The second option is that you put your money risk free on the bank for 0.5% interest per year for the next month. You are free to decide how much you want to invest in each one.

How much of your $\in 10,000$ do you want to invest in the cryptocurrency? The more you slide to the right the more you invest in the cryptocurrency and the rest you invest you will put in the bank for 0.5% interest per year.

This is monthly investment 2/5.



Below you can find two graphs. Graph 1 shows the price development of last month. The % that is in graph 1 is the profit or loss you have made on the cryptocurrency investment last month. Graph 2 shows the total price development of the cryptocurrency. The risk free investment of putting your money in the bank made 0.04% (1/12 of 0.5%).

Assignment upcoming month (same information as last investment)

You have the same two options as last time. The first option is to invest your money in the same risky cryptocurrency investment for the next month. The second option is that you put your money risk free on the bank for 0.5% interest per year for the next month. You are free to decide how much you want to invest in each one.

How much of your $\in 10,000$ do you want to invest in the cryptocurrency? The more you slide to the right the more you invest in the cryptocurrency and the rest you invest you will put in the bank for 0.5% interest per year.



This is monthly investment 3/5

Investment amount in cryptocurrency on 1st of May till 31st of May.

0

Below you can find two graphs. Graph 1 shows the price development of last month. The % that is in graph 1 is the profit or loss you have made on the cryptocurrency investment last month. Graph 2 shows the total price development of the cryptocurrency. The risk free investment of putting your money in the bank made 0.04% (1/12 of 0.5%).

Assignment upcoming month (same information as last investment)

You have the same two options as last time. The first option is to invest your money in the same risky cryptocurrency investment for the next month. The second option is that you put your money risk free on the bank for 0.5% interest per year for the next month. You are free to decide how much you want to invest in each one.

How much of your $\in 10,000$ do you want to invest in the cryptocurrency? The more you slide to the right the more you invest in the cryptocurrency and the rest you invest you will put in the bank for 0.5% interest per year.

This is monthly investment 4/5



Investment amount in cryptocurrency on 1st of June till 30th of June.

Below you can find two graphs. Graph 1 shows the price development of last month. The % that is in graph 1 is the profit or loss you have made on the cryptocurrency investment last month. Graph 2 shows the total price development of the cryptocurrency. The risk free investment of putting your money in the bank made 0.04% (1/12 of 0.5%).

Assignment upcoming month (same information as last investment)

You have the same two options as last time. The first option is to invest your money in the same risky cryptocurrency investment for the next month. The second option is that you put your money risk free on the bank for 0.5% interest per year for the next month. You are free to decide how much you want to invest in each one.

How much of your $\in 10,000$ do you want to invest in the cryptocurrency? The more you slide to the right the more you invest in the cryptocurrency and the rest you invest you will put in the bank for 0.5% interest per year.



This is monthly investment 5/5

Test whether participant understood experiment

- 1. In this experiment: the more you slide to the right the more ...
 - (i) You invest in the cryptocurrency.
 - (ii) In the safe bank investment.
- 2. In this experiment: the money that you do NOT invest in the cryptocurrency will be invested in
 - (i) Risky stocks.
 - (ii) In a safe bank investment.
- 3. 3. Do you have an idea about what specific cryptocurrency the experiment was about?(i)

Risk profile questions

- 1. When you think of 'risk' in a financial context, which comes to mind first?
 - (i) Possible gains
 - (ii) Could gain or lose
 - (iii) Possible loss
- 2. How big a loss across all your investments would have to occur before you began to feel uncomfortable?
 - (i) I would be uncomfortable by the time my losses reached 10%
 - (ii) I would get uncomfortable when my losses were between 10% to 20%
 - (iii) It would take losses of at least 25% before I became uncomfortable
- 3. This chart below shows the highest one-year gain and the highest one-year loss on three different hypothetical investments of \$10,000.
 - (i) I would pick Investment A
 - (ii) I would pick Investment B
 - (iii) I would pick Investment C



Person characteristics questions

- 1. What is your gender?
 - (i) Male
 - (ii) female
- 2. What is your age?
 - (i) 1-20
 - (ii) 21-30
 - (iii) 31-40
 - (iv) 41-50
 - (v) 51-60
 - (vi) 61-70
 - (vii) 71+
- 3. Do you have a financial background (educational or work)?
 - (i) Yes
 - (ii) no
- 4. Have you invested in financial markets before (stocks, bonds, index funds)?
 - (i) Yes
 - (ii) no
- 5. Have you invested in Bitcoin before?
 - (i) Yes
 - (ii) No
- 6. What were your considerations when you decided how much to invest in the Bitcoin?
 - (i) ...