Changing Cryptocurrency Perceptions: An Experimental Study

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Affidavit

I hereby affirm that this Bachelor's Thesis represents my own written work and that I have used no sources and aids other than those indicated. All passages quoted from publications or paraphrased from these sources are properly cited and attributed.

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Abstract

Since the launch of Bitcoin in 2009, the cryptocurrency market has significantly evolved and is beginning to introduce itself into global financial institutions. A major factor causing the development and growth of cryptocurrencies is due to an increase in public awareness and adoption, which led to cryptocurrencies challenging global commodity currencies and being a preferred payment instrument. From this, it can be derived that public perceptions of cryptocurrencies are influencing factors for the future growth, adoption, and use of cryptocurrencies as a global payment instrument.

This research paper identifies how people's cryptocurrency perceptions can be altered with the use of positive and negative cryptocurrency information. This is done by assessing the technological attributes and people's perceptions of cryptocurrencies, which were made the variables in this research paper and include trust, security, privacy, financial gain, sustainability, and perceived risks. Previous research has explained why these attributes are major influencers of people's perceptions of cryptocurrencies and why they determine a person's willingness to adopt them. To understand how people's perceptions of cryptocurrencies change, an online survey was created where participants were asked to answer a set of questions about the attributes of cryptocurrencies based on their opinions, and then answer the same set of questions following a positive or negative video about cryptocurrency attributes. The survey results were analyzed to determine which of the questions were significantly impacted by the video, as well as which survey caused a greater change in the survey results. The results have shown that several of the participants' cryptocurrency perceptions were altered following the video intervention. Furthermore, a significant difference was identified in at least one of the questions from each of the considered variables. Moreover, the results have shown which of the two surveys caused a greater change in the participants mean responses before and after the video. Participants that had previous cryptocurrency experience have shown to be less concerned about the potential risks of cryptocurrencies, due to having prior experience and knowledge of them. Changing public perceptions of cryptocurrencies is possible and is relative to the type of information a person is exposed to.

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1 Introduction

Over the last decade, the use, application, and adoption of cryptocurrencies has developed to an extent, that they now challenge the biggest commodity currencies, such as the Dollar, Euro, Yen, etc. (Nagpal, 2017). Since the creation of the first cryptocurrency Bitcoin in 2009, Bitcoin has retained its structure, however, has managed to integrate itself into contemporary, changing world economies, through increased customer demand (DeVries, 2016). Cryptocurrencies based on blockchain ensure data privacy and security to consumers; one of the key reasons for cryptocurrencies' success in the financial industry (Banerjee et al., 2018).

A cryptocurrency is a digital asset based on encryption that can be used as a medium of exchange in a peer-to-peer network (DeVries, 2016). In order to record transactions, cryptocurrencies rely on the blockchain (Banerjee et al., 2018). The blockchain is a distributed ledger technology that records peer-to-peer transactions in the form of blocks (ibid). The blockchain is considered a secure network for recording transactions, due to the complexity of altering information and its difficulty of being hacked (Wang et al., 2018). Therefore, because cryptocurrencies rely on the blockchain to record all transactions, it makes cryptocurrencies more secure, private, and personal, which is one of the crucial reasons why many prefer it over commodity currencies (ibid). The most popular cryptocurrency, with the biggest market capitalization ($1.058 trillion as of April 2021) is Bitcoin (*Cryptocurrency Prices, Charts And Market Capitalizations*, n.d.-a). Furthermore, it is decentralized, as it is not controlled by the government (Klarin, 2020).

1.1 Practical Relevance

The findings of this research paper will contribute to the existent literature in many ways. The first contribution is to understand how people's perceptions regarding cryptocurrencies change in the case that they are exposed to positive and negative cryptocurrency information. The second contribution will be to understand the concerns that people have regarding cryptocurrencies, which inevitably determines the barrier between cryptocurrency and its adoption. The third contribution is to use previous research to help to predict the future applications and use cases of cryptocurrencies in the financial technology industry. The last contribution will be to

predict the growth and adoption of cryptocurrencies, due to an increase in customer demand, by looking at the past development in cryptocurrency adoption.

The importance of this topic is that it will introduce the movement from commodity currencies to cryptocurrencies by analyzing how people's cryptocurrency perceptions can be altered. Moreover, once cryptocurrencies begin to take their position in the world economy, more users will be aware of what cryptocurrencies are, and why they should be chosen over previously used commodity currencies. By being an early adopter of cryptocurrencies, one becomes more aware of some of its applications, for example trading and the purchasing of goods and services, which can have a greater advantage over others (for example by purchasing a certain amount of cryptocurrencies today, knowing that its worth will increase in the future, due to the increase in demand).

The biggest factor that determines the future of cryptocurrencies are the perceptions of people regarding its use, adoption, and application, as well as some of its attributes such as trust, security, privacy, financial gain, sustainability, perceived risks, etc. This paper will study the perceptions of individuals regarding cryptocurrencies, as well as how their perceptions change after they are exposed to positive and negative information about them. This will help to determine the extent to which people are interested and willing to buy cryptocurrencies, which will decide upon its impact on the world economies.

1.2 Aim of Research

In this thesis I investigate to predict what factors influence and determine an individual's perception of cryptocurrencies and how those perceptions can be altered with positive and negative information. From this, the main research question can be formulated as:

RQ: *How do people's perceptions change regarding cryptocurrencies, when they are exposed to positive and negative cryptocurrency information?*

Questions that need to be considered when answering the main research question are:

- *To what extent is a risk-averse person less likely to invest into cryptocurrency?*
- *Does gender impact the likelihood to invest into cryptocurrency?*
- *To what extent do perceived cryptocurrency risks differ between a person with no cryptocurrency experience and a person with previous cryptocurrency experience?*

All of these questions will be answered with an evaluation of existing literature in the literature review and the survey.

2 Literature Review

2.1 Blockchain

Similarly to Bitcoin, the blockchain was first proposed in 2008, and implemented in 2009 (Wang et al., 2018) and was used by Satoshi Nakamoto as a core component of cryptocurrency (Al-Essa, 2019). The blockchain is a public ledger, that stores all cryptocurrency peer-to-peer transactions as blocks in the chain (ibid). The blockchain is built up on asymmetric cryptography and a distributed consensus algorithm (ibid). In the blockchain technology, transactions are not based on trust, but mainly based on proof of the two users that are involved in the cryptocurrency transaction, therefore making a third party unnecessary (ibid). Furthermore, the blockchain technology is able to perform its work in a decentralized environment, which can be done by integrating some of the fundamental technologies, such as the cryptographic hash, the digital signature (which refers to the asymmetric cryptography mechanism) and a distributed consensus mechanism, which all contribute to the verification of a transaction (Wang et al., 2018). Due to these factors, the blockchain can remain efficient and secure, and also greatly reduce costs of financial transactions, which is a trend our world is leading up to. Today, Bitcoin and cryptocurrencies remain the most popular application of the blockchain.

In order to explain the process of the blockchain technology, it is best to take an example of a simple, daily transaction that involves the use of the blockchain; Jonathan's online purchase of a coffee mug on AliExpress.

1. In order for a block to be added onto the blockchain, a transaction must occur. Jonathan has decided to buy a new coffee mug on AliExpress and has placed a purchase order for it. In most cases, Jonathan's transaction will be placed together with thousands of other transactions in the same block, meaning his information will be stored with the transaction information of other's (time, date, and price) (Reiff, 2020).
2. The transaction that has been made must be verified by a network of computers (ibid). The network of computers verify that the transaction occurred with the same credentials as Jonathan has placed his order for (ibid). The computers verify the time, price, and participants of the transaction (ibid).
3. After Jonathan's transaction has been verified, the information of the transaction must be stored in a block, which will contain hundreds or thousands of transactions similar to his (ibid).
4. The created block must be given a hash (ibid). A hash is a unique code that contains inputs of letters and numbers, and once it is encrypted, it becomes a code of a fixed length (Wang et al., 2018). The block is given the hash of the last block that is added to the blockchain, which is also known as the parent block (ibid). Once the block is hashed, it can finally be added to the blockchain (Reiff, 2020).

Generally, the blockchain technology is known for its 4 key characteristics (Wang et al., 2018).

- **Decentralization** refers to any peer-to-peer transaction, without the involvement of a central agency (Wang et al., 2018).
- **Immutability** refers to the complexity of changing and altering information that has already been verified and exists on the blockchain (ibid). Any falsification would be easily recognized (ibid).

- **Auditability** refers to the simplicity of tracing previous transactions, as they have been verified and recorded with the transaction's information on the blockchain (ibid). This facilitates the tracing of previous transactions (ibid).
- **Anonymity** refers to the absence of a central party that keeps track of a user's information, therefore providing privacy to each user (ibid). On the other hand, due to the intrinsic constraints, blockchain privacy cannot always be guaranteed (ibid).

2.2 Cryptocurrency

In 2008, an unknown figure to this day, Satoshi Nakamoto, created Bitcoin, the first and most popular cryptocurrency in the world (DeVries, 2016). Cryptocurrency is an encrypted digital currency that is used to conduct secure and private peer-to-peer transactions in exchange networks (ibid). Bitcoin is a cryptocurrency and is not electronic money, as electronic money is simply money that is deposited into an account through a payment terminal or bank, meanwhile cryptocurrency is an asset produced through the internet and not associated with any usual currencies (Bondarenko et al., 2019). Although Bitcoin's structure has remained the same since its launch in 2009, the impact of constantly changing and fluctuating world markets has created a greater consumer demand for cryptocurrencies, more than expected back in 2009 (DeVries, 2016). The main reason for this increase in demand is because of the exponential growth in the price of cryptocurrencies, especially Bitcoin, which has grown over 5000% since April 2017, when the first major awareness of cryptocurrencies arose (Conti et al., 2017). Therefore, the public wanted to exploit Bitcoin's weakness for profit, causing the awareness of and use of cryptocurrencies to exponentially increase (ibid). Another reason for this increase in demand, is the decentralization of cryptocurrencies, meaning users are able to have self-control over their assets, which is different to centralized authorities, such as banks, that are in control of your assets, without the user knowing where this money is going and what it is used for (ibid). Another reason for this is the growth of the digital space and digital technologies, which are increasing in popularity as they facilitate daily processes by making them safer, faster, and more trustworthy, such as paying, investing, lending, etc. (Bondarenko et al., 2019).

There are many services and platforms that report and update information regarding cryptocurrencies (such as prices of cryptocurrencies, news, upcoming Initial Coin Offerings, etc.), and the most popular and easy-to-use platform for tracking cryptocurrency information is *Coinmarketcap*. One variable that determines the "popularity" of a cryptocurrency is its market capitalization, which is calculated by multiplying the total amount of coins in circulation by the current market price of a single coin. Figure 1.1 presents some noteworthy cryptocurrency statistics taken from Coinmarketcap.

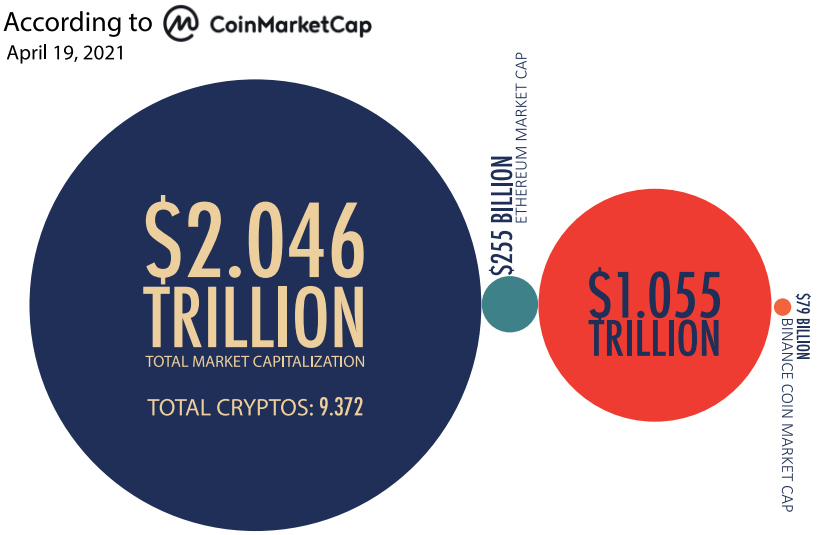

Figure 1.1 – Cryptocurrency statistics as of April 19th, 2021

From figure 1.1, it can be seen that Bitcoin is the biggest cryptocurrency by market capitalization, and holds a 51.6% market capitalization dominance against all other altcoins, including Ethereum (ETH), Binance Coin (BNB), and all of the other 9369 cryptocurrencies as of date. An altcoin is any cryptocurrency other than Bitcoin.

Looking at the statistics of cryptocurrency growth, in 2013, only a mere 8 cryptocurrencies existed (Nagpal, 2017) and this figure has grown to 9,346 cryptocurrencies as of April 2021, with new cryptocurrencies still launching through ICO's (Initial Coin Offerings) (Klarin, 2020). According to Coinmarketcap and figure 1.1, the market capitalization of cryptocurrencies has increased from $2 billion to $18 billion from 2013 to early 2017 and spiked at a market capitalization of $2.2 trillion on February 16th, 2021 (*Cryptocurrency Prices, Charts And Market Capitalizations*, n.d.-a).

The year 2017 - early 2018 and end of 2020 – April 2021 is a time of the "*cryptocurrency hype*", in which cryptocurrency made its major appearance in the eyes of the public. However, looking at the current market capitalization and demand, it can be stated that April 2021 is the highest rate of cryptocurrency awareness, where people are most likely to adopt cryptocurrencies, to not fall back on trends and make a return on their investment.

2.2.1 Applications of Cryptocurrencies

With an increase in awareness and popularity of cryptocurrencies, its applications have continued to develop, and many daily activities now involve the use of cryptocurrency due to its favorable technological attributes, in comparison to previously used commodity services (Nagpal, 2017). The most popular use of cryptocurrency is revolved around financial and payment services (ibid). Such services include investing into digital assets, cryptocurrency trading, purchasing goods and services, and sending or receiving money (ibid).

Firstly, cryptocurrency makes it possible for users around the world to invest in any digital asset, and potentially gain a return on their investment, which is the overall goal of any investor (Chuen et al., 2017). Users begin to see a change in their invested value once the price of the bought cryptocurrency changes, for example, if the price of a cryptocurrency is higher than the price the user has initially purchased for, the user is making a profit on their investment, and vice-versa. The worth of a cryptocurrency is determined solely by the market and derived by its supply and demand, and functions similarly to commodities on the stock market (Nagpal, 2017). As described in Mikhaylov's (2020) paper *"Cryptocurrency Market Analysis from the Open Innovation Perspective",* the volatility of the cryptocurrency market is caused by investor sentiment, which states that the market-wide sentiment has a stronger impact on cryptocurrencies, as once a user sees a rise in the price of a cryptocurrency, they have a positive investor sentiment, leading to an increase in demand for that token. Cryptocurrency can be an attractive investment due to its volatility in price, making it riskier, which is not so apparent with other investment opportunities, such as stock investment, foreign exchange investment, etc. that have less volatility and lower risk (Chuen et al., 2017). Cryptocurrencies like Bitcoin have a finite amount that will ever be generated, which is 21 million (out of which 18.7 million have already

been mined), meaning Bitcoin is scarce, which gives it "intrinsic" value, which could be an influential factor in its price (Brekke & Fischer, 2021). Furthermore, there are many ways to adopt cryptocurrencies. Some of the most popular ways include through cryptocurrency exchange systems (Binance, Coinbase, Kucoin, etc.), through certain banks that offer cryptocurrency purchasing and investment such as Revolut, Cashaa, etc. and even through vending machines (ibid). The accessibility of adopting cryptocurrencies also makes the investment more attractive, which is partially due to its decentralized attributes, making anyone with an internet access applicable to own cryptocurrencies (ibid). The partial explanation for the growth of the total cryptocurrency market capitalization is because the general public and firms have realized the potential returns of investing into cryptocurrencies and wanted to join the bandwagon, and by adopting cryptocurrencies, the market capitalization increased. For example, according to Coinmarketcap, since Bitcoin surpassed its previous all-time-high market capitalization of 2018 ($279 billion) in November 2020, its price went up by 253% as of time of writing and seeing these potential investment gains are very attractive to the public (*Cryptocurrency Prices, Charts And Market Capitalizations*, n.d.-b). A study by Glaser et al. (2014) has revealed that when a user purchases Bitcoin, the main reason is for a speculative investment (Baur et al., 2017). This is why the demand for cryptocurrency investment increased, causing an increase in cryptocurrency prices and total market capitalization.

Secondly, following the purchasing of cryptocurrencies, they can be used to trade with on different cryptocurrency exchange markets, with the intent of making a profit on the investment (Muftic et al., 2017). Once a cryptocurrency is purchased, the user decides on their own strategy and decision of how they will use their cryptocurrency to make a profit (ibid). There exist three types of trading strategies, namely technical, fundamental, and recently, quantitative (Fang et al., 2021). A technical trading strategy involves an analysis of the historical patterns of transaction data, which is used by traders to determine the current and future market conditions, in order to make a return on the investment (ibid). A fundamental trading strategy involves an analysis of the events of the cryptocurrency company to determine when the cryptocurrency should be bought and sold for profit (ibid). A quantitative strategy is similar to a technical one but uses a technical software to conduct the trades for the user, by looking at the prices, volume, technical indicators, etc. (ibid). If the user

decides to take out their investment and put it into a different cryptocurrency, it can be done through pairs such as BTC/ETH, XRP/BTC, etc. where the user pays lower transaction fees than first changing their cryptocurrency to a fiat cryptocurrency (BTC/USDT for example), and then purchasing their desired cryptocurrency (ETH/USDT for example). There are lots of advantages to cryptocurrency trading. Firstly, the cryptocurrency trading market is a 24-hour market, allowing users to trade at any time they want (ibid). This is unlike the stock market where trading is possible only on weekdays from 9:30AM – 4PM, which is because stocks are centralized, meanwhile cryptocurrencies are decentralized. Secondly, trading cryptocurrencies is pseudonymous, and does not make the traders identity public, which provides an advantage regarding user privacy (ibid). Thirdly, because cryptocurrencies are based on peer-to-peer transactions, they do not rely on financial institution intermediaries, resulting in fewer transaction fees for the trader (ibid).

Thirdly, cryptocurrencies are widely used to purchase goods and services not only online, but also in brick-and-mortar facilities. As of right now, cryptocurrency can be used as an alternative monetary equivalent to money that is issued by a central authority, however, is decentralized and more secure (Sukarno & Pujiyono, 2020). Companies accepting cryptocurrency payments are increasing, some of the current notable ones being Barnes & Noble, Baskin Robbins, GameStop, Amazon's Whole Food Market, etc. (ibid). The process of paying for goods and services is done through initiating an order for the good or service, deciding on the cryptocurrency token needed for the transaction, transferring the required amount of cryptocurrency onto the account of the seller, and once the payment is received, the customer can receive their good or service (Semenchuk & Andreev, 2019). Another option of paying with cryptocurrency is through Crypterium's global *"Crypto Debit Card"*, where the user can top up a virtual or plastic card with cryptocurrencies, which are then converted into fiat money and can be used for purchasing goods and services offline and online and withdrawing funds from an ATM (Crypterium, n.d.). In 2018, Crypterium created a customer survey to better understand how to increase customer adoption of cryptocurrencies, and out of the 400,000 participants, 70% of them stated that cryptocurrency cards are needed for mass adoption and issuing them was a great leap towards the overall awareness, adoption, and use of cryptocurrencies in day-to-day activities (ibid). Once awareness about attributes of cryptocurrencies such as

decentralization, security, privacy, and time saving increase, this will lead to an increase in the use and adoption of cryptocurrency paying methods, on a public and corporate scale.

Lastly, cryptocurrency is used as an instrument for transferring and receiving money from anyone in the world in a much faster and cheaper matter. The finances that a cryptocurrency user holds can be found in the cryptocurrency wallet of the user, and when transferring funds to another user, it is sent to their wallet. A cryptocurrency wallet is a digital wallet, essentially a computer program, that provides the user access to data on the blockchain, which can then be seen by the user, as well as have the user add new information onto the blockchain (Semenchuk & Andreev, 2019). In other words, cryptocurrency wallets have access to the users public and private keys, allowing users to keep track of their cryptocurrencies, and to receive and send cryptocurrencies (ibid). By using cryptocurrencies for sending and receiving money, individuals that are unknown to each other can safely perform transactions without a third-party intermediary, and do not need to trust one another (Muftic et al., 2017). A practical benefit of being able to send any digital asset to another user is that a guarantee exists for the safety of the transfer of funds, and this cannot be challenged, due to the use of the blockchain public ledger in cryptocurrency transactions (ibid). Another benefit of transacting with cryptocurrency are the low transaction fees in comparison to other financial service companies such as Western Union. For instance, by using the TRC-20 (a technical standard that is used for smart contracts on the Tron Blockchain) to send USDT (Tether, a stablecoin) to another cryptocurrency wallet, the user sending the digital assets pays a 1$ transaction fee for any amount they wish to send (TRON Developer Group, 2021). Another useful benefit of transacting with cryptocurrency is the speed of the transactions (Titov et al., 2021). For instance, sending Bitcoin from one cryptocurrency wallet to another takes between 1-60 minutes, and 10-20 minutes on average (ibid).

Overall, the main abilities of cryptocurrencies can make them more attractive to the public, as they are more secure, time efficient, and cheaper than traditional financial services, and I believe an increase in the awareness of these factors will increase the adoption and the use of cryptocurrencies in the future.

2.2.2 Mining

There are a number of ways how cryptocurrencies can be created and released into market circulation for purchasing and trading. One way of creating cryptocurrency is through “mining”, which is how more Bitcoin, Monero, Ethereum Classic, etc. are released into market circulation (Aljabr et al., 2019). To describe the process of cryptocurrency mining, Bitcoin will be taken as an example. Bitcoin mining involves the blockchain, which records cryptocurrency transactions in the form of blocks, in which each block contains a hash value and the hash value of the preceding block (Eyal & Sirer, 2013). A valid block on the blockchain contains a solution to a complex mathematical puzzle, which involves the hash of the preceding block, the hash of the transactions in the block at hand, and a Bitcoin address, to which rewards for solving the mathematical puzzle will be sent (ibid). In order to create a new block and find a suitable and unused hash, a node (a powerful computer running the Bitcoin software and the blockchain) is used, and this process is what is known as Bitcoin mining (ibid). The miners then attempt to obtain the “Proof-of-Work” and the first node which solves the complex mathematical puzzle and finds the hash is rewarded with 6.25 BTC (as of time of writing), and this is how new Bitcoins are released into the market circulation, which happens approximately every ten minutes and generally consumes a lot of memory space and energy (ibid). Another popular process of creating cryptocurrency tokens is through the forging algorithm, which uses a consensus of “Proof-of-Stake” instead of “Proof-of-Work”, and is generally considered faster, more ecological, and utilizes less energy, making it a cheaper and more sustainable alternative (Popov, 2016).

2.3 Characteristics of Cryptocurrencies

In order to understand why cryptocurrencies are so revolutionary, it is important to look at the characteristics that explain why this asset can impact world economies in the future and integrate itself into people’s everyday lives.

2.3.1 Decentralization

Decentralization in cryptocurrency means that there is no single group or institution that controls the cryptocurrency network, and that the owner of the cryptocurrency is in full control of it (Fang et al., 2021). The decentralized attributes of cryptocurrency

make them more attractive to the general public, which is one of the main reasons why people turn to cryptocurrencies (Radivojac & Grujić, 2019), and why it has potential in the financial industry in the future. It becomes attractive to the public as the users can have full control over their money, and do not have to worry about a bank or government not being able to pay them the full amount, in the case of a potential bankruptcy of the bank, or a poor government economy (ibid). Furthermore, this means that people can now purchase goods and services, without the government knowing about the purchase (ibid). However, this has caused great speculation by the Financial Crimes Enforcement Network, the FBI, etc. as decentralized transactions have made it possible to conduct illegal activities, such as money laundering, drug selling, the smuggling of weapons, etc. (ibid). Unfortunately, unless cryptocurrency will be recognized and supported by the government of a country, it will be almost impossible for everyone to switch to solely using cryptocurrencies (Frebowitz, 2018). This is because it would make it difficult for the government to keep track of the salaries of their country's employees, and that way the employees could avoid paying taxes on their salaries (ibid). For the government to be in full support of cryptocurrency, it needs a way to track the monetary inflows and outflows of the persons account, which would eliminate cryptocurrency's attribute of decentralization (ibid). Generally, decentralization makes cryptocurrency more private, as your cryptocurrency transactions are pseudonymous and more secure, as users are able to have full control over their finances.

2.3.2 Security of Cryptocurrencies

The security of cryptocurrencies is an influential factor in determining the adoption and growth of cryptocurrency use in the future. In this section, Bitcoin and the Bitcoin network will be evaluated. Three factors that make up cryptocurrency security are the blockchain & mining, consensus, and key management (Conti et al., 2017).

The blockchain assists cryptocurrency by integrating its entire network transaction history into its public ledger (ibid). Tempering with information already on the blockchain is almost impossible, due to the changes in the hash values of the current and subsequential blocks (ibid). This ensures security, as hackers are not able to falsify previously placed data on the blockchain. The miners play an important role in regulating the blockchain, for example miners have to verify the creation of a block

that will be added onto the blockchain by solving a mathematical crypto puzzle, and if this is done fairly, miners are rewarded with 6.25 Bitcoin as of time of writing (ibid).

The consensus protocol refers to the Proof-of-Work (PoW) consensus algorithm. PoW is a decentralized consensus system that requires solving a complex mathematical puzzle, resulting in creating a block on the blockchain, and being rewarded for it (Conti et al., 2017). Therefore, because a financial and time investment is required to start mining, it gives an incentive to miners to be fair with their work in the blockchain, as if there is any cheating involved, the miner is forever banned from the Bitcoin network, and therefore would lose money on their initial investment (ibid). Furthermore, this eliminates any cryptocurrency user having absolute power over the blockchain, as even users with a high capital cannot influence the decisions of the entire blockchain (ibid). Generally, PoW manages the high scalability of nodes that want to take part in mining, and also remains fully decentralized. However, the PoW network is still prone to attacks, such as the ones mentioned in table 1.1.

Key management refers to a cryptocurrency user being in control of their public and private keys, and how it creates more security in the system. The benefit of a private key is that hackers are unable to steal Bitcoin from an account without having the private key of the user, as they do not have access to spending the cryptocurrency in the form of digitally signed transactions (Conti et al., 2017). Considering the private key is usually kept offline, it makes it exponentially harder for the hacker to obtain it (ibid). Furthermore, the use of the hash of the public key for receiving transactions from others provides anonymity to the user, and also cannot be used to hack into the system of the user (ibid).

However, the blockchain is not fully secure from attacks, as incidents and attempts of attacks have previously happened. Table 1.1 presents a chart with some of the major attacks on cryptocurrencies and the Bitcoin network.

Table 1.1 – Attacks on the Bitcoin network and the PoW consensus protocol

Attack	Description	Primary Target	Impact on User	Potential Countermeasures
Double Spending	Spending the same Bitcoin's in different transactions or sending the same Bitcoin to two different cryptocurrency addresses	Sellers or merchants	Sellers lose their cryptocurrencies and create blockchain forks	Hiring observers in the blockchain to regulate double spending and create an environment where all merchants communicate any known double spending efforts.
>50% Hashpower	Adversary has control of over 50% of the Hashrate	Miners, cryptocurrency exchange systems, Bitcoin network, users	Weakens the consensus algorithm	Hiring observers in the blockchain to regulate double spending and create an environment where all merchants communicate any known double spending efforts. Also, set limits on mining pool sizes.
Finney Attack	Miner dishonesty by presenting a pre-mined block in order to double spend	Sellers or merchants	Facilitates double spending	Waiting for multiple transaction confirmations.
One Confirmation Attack	A combination of the finney attack and double spending	Bitcoin exchange services	Facilitates double spending of larger amounts of Bitcoin	Waiting for multiple transaction confirmations.
Selfish Mining	Takes advantage of Bitcoin forking, resulting in an unfair reward	Mining pools (honest miners)	Wastes the electricity of honest miners and may lead to >50% Hashpower	Timestamp based techniques, for example freshness preferred.
Block Withholding	The miner presents only the Particular Proof-of-Work and not the Full Proof-of-Work.	Mining pools (honest miners)	Reduces the revenue of miners and wastes their resources	Only keep known and trusted mining pools for the Bitcoin network.
Brute Force Attack	Private mining on blockchain fork to eventually double spend	Sellers or merchants	Facilitates double spending	Hiring observers in the blockchain to regulate double spending and create an environment where all merchants communicate any known double spending efforts. Also, set limits on mining pool sizes.

(Conti et al., 2017).

2.3.3 Trust factors of Cryptocurrencies

Trust can be defined as the willingness of a person to be vulnerable to the actions of another party, assuming that the other party's actions will meet the expectations of the trustor, without his or her involvement and monitoring (Marella et al., 2020). The trust that the public has in cryptocurrencies is crucial for their further adoption, use, and growth. More specifically, trust in cryptocurrencies is determined by the users trust in the underlying technology of cryptocurrencies (ibid). This is because while financial intermediaries (such as banks) guarantee the security of their financial services and are backed up by legislations and institutions of central authorities, cryptocurrencies are only backed up by the correct functioning of their technological elements, which are the blockchain, cryptocurrency wallets, and cryptocurrency exchange systems (ibid). The blockchain does not allow for previously inserted data to be falsified, cryptocurrency wallets are allowed to be kept on an external software, and cryptocurrency exchange systems contain lots of verification before funds can be sent to another wallet, and all of these 3 factors play a role in increasing the trust of cryptocurrencies (ibid). Although there exists lots of literature on trust, research on trust in technology is limited, but very demanded (ibid). One of the main questions to be answered is how to increase the public's trust in cryptocurrencies, resulting in cryptocurrency adoption and integration into everyday tasks (ibid).

A research paper by Marella has revealed lots of useful information regarding trust in cryptocurrencies and its technologies, referring to Bitcoin as the main example (Marella et al., 2020).

Coin transfers, immutability, openness, and decentralization are the main attributes that create trust in cryptocurrencies, such as Bitcoin. (ibid). Users stated that transferring Bitcoin is faster than transferring fiat currencies (ibid). Immutability refers to the inability to falsify information on the blockchain (ibid). Openness refers to information being public on the blockchain (ibid). The openness, immutability, and blockchain structure are the features of the cryptocurrency technology that contribute to trusting Bitcoin. An increase in the awareness of these factors should positively influence people's trust in cryptocurrencies and make them more likely to adopt them.

Similarly, this study also revealed that stability, regulation, security, and knowledge of Bitcoin would make cryptocurrencies a reliable technology, resulting in an increase in adoption (ibid). Stability refers to the volatility of Bitcoin and having more stable Bitcoin and other cryptocurrency prices would make it more reliable (ibid). Regulation refers to Bitcoin being legally regulated (ibid). Security refers to an improvement in the security measures of cryptocurrency exchange systems and wallets, resulting in more reliability in Bitcoin (ibid). Knowledge refers to the knowledge regarding Bitcoin technology, which would make it more trustworthy, as users would be able to make better investment decision, resulting in higher profits (ibid). The factors of stability and regulation of Bitcoin cannot be altered, as Bitcoin remains a digital asset and its volatility is determined solely by the market's demand and supply and adding regulations would make Bitcoin and other cryptocurrencies centralized, and may lead to more people abandoning their cryptocurrencies, which would result in more harm than good for the future adoption and use of cryptocurrencies.

Overall, when analyzing trust factors of cryptocurrencies, it is the underlying technology that determines a person's trust in cryptocurrencies. An increase in the knowledge of cryptocurrency technology would lead to an increase the public's trust and awareness, and result in cryptocurrency adoption.

2.3.4 Privacy in Cryptocurrencies

Privacy in cryptocurrencies refers to the user's privacy and anonymity when using and owning cryptocurrencies and is one of the main drivers of cryptocurrency success in the financial markets. Cryptocurrencies like Bitcoin are pseudonymous, as each Bitcoin user has a unique address, which cannot be identified publicly (unless the user shares their address publicly), and acts as a pseudonym when transacting (Conti et al., 2017). Therefore, unless a Bitcoin's public keys or hashes are exposed to the public, it is difficult to identify a cryptocurrency user, which is an advantage over central authorities that have access to users' funds and store their customers identification details (ibid). However, not all cryptocurrencies are pseudonymous and are more anonymous, for example ZeroCash (Zcash), which is a decentralized cryptocurrency that uses an improved version of the zero-knowledge-proof called *zk-SNARKs* (Zero-Knowledge-Succinct Non-Interactive Argument of Knowledge), and avoids revealing sensitive transaction information, such as the amount and recipient address, and

meets high privacy standards (Alsalami & Zhang, 2019; Conti et al., 2017). Monero (XMR) is another decentralized cryptocurrency that focuses on providing anonymity to cryptocurrency, as well as protecting user privacy (ibid). Monero helps to make transactions more challenging to trace by using stealth addresses and ring signatures, which do not reveal identities of the sender and receiver (ibid). A ring signature is a digital signature with no trusted managers, where any group individual can sign on the behalf of a group (ibid). Furthermore, Monero has created an additional privacy feature called *Ring Confidential Transaction (RingCT),* which does not reveal transaction amounts and enables cheaper transaction fees and even more privacy to users (ibid). The existence of ZeroCash and Monero provide benefit to cryptocurrency, as they enable more privacy technologies and standards, and can positively influence the public's perceptions on the privacy of cryptocurrencies.

Unfortunately, privacy in Bitcoin exists only because of the pseudonymous addresses, and these addresses can be compromised through different techniques, for example payment tracking through the blockchain analysis, IP address monitoring, web spidering, etc. (Conti et al., 2017). Once a user's identity is identified, this privacy factor can be difficult and costly to recover (ibid).

On the other hand, it is possible to improve cryptocurrency user privacy and anonymity without changing its fundamental technologies (ibid). One way to do this is through peer-to-peer mixing protocols (ibid). In mixing, a user's funds are split into smaller amounts, and are then randomly mixed with random cryptocurrencies of other random users, making the initial user end up with entirely different cryptocurrencies, which helps to eliminate the connection between the user and the coins they purchased, resulting in user anonymity (ibid). Third party mixing protocols already exist, such as *MixCoin*, to which a user can send their cryptocurrency, and then receive back an equivalent of the cryptocurrency from another user, ensuring strong anonymity from external entries (ibid). If cryptocurrency technology could provide full animosity to its users, it would undoubtedly remove perceived privacy risks of the public, leading to an increase in adoption and awareness of cryptocurrencies.

2.3.5 Electricity Consumption

Electricity consumption in cryptocurrencies refers to the environmental impact of obtaining cryptocurrencies. Recent concerns have arose regarding CO_2 and natural gas emissions from the exploitation of Bitcoin and other cryptocurrencies (Badea & Claudia, 2021). PoW and PoW / PoS methods are currently used for Bitcoin mining and require high computing power and energy-intensive technologies (ibid). It is estimated that the Bitcoin network has consumed 87.1 terawatt-hours (TWh) from September 2018-2019, which is close to the total energy consumption of Belgium, and in 2020 this yearly figure increased to 121.36 TWh, which is more than the total energy consumption of Argentina (Badea & Claudia, 2021; Criddle, 2021). In 2018, it was estimated that $1 worth of Bitcoin mining was responsible for $0.49 worth of climate and health damages in the US, and $0.37 in China (Badea & Claudia, 2021). Estimation methods used for analyzing the Bitcoin network electricity consumption are the Cambridge Bitcoin Electricity Consumption Index (CBECI) and Bitcoin Energy Consumption Index (BECI) (Badea & Claudia, 2021). However, these electricity consumptions figures are not expected to decrease, as the miners are more concerned with their potential profits and not the environmental impact, therefore, if the price of Bitcoin continues to increase, electricity consumption for mining will increase and vice versa (ibid). Currently most of the Bitcoin mining happens in China (58% of total Bitcoin mining), as miners tend to prefer geographical areas where electricity is cheap, such as China, to maximize their financial gains (ibid). Electricity in China is mainly obtained through coal, which releases more CO_2 into the atmosphere than oil and gas, and negatively impacts climate change (ibid). If the marginal cost of mining would be higher than the financial gain, miners would have no reason to continue their work (ibid).

Bitcoin is not the only cryptocurrency whose carbon footprints are high, for example, Monero's creation had an estimated electricity consumption of 645.62 GWh in 2018, which could indicate that while Monero creates more privacy for cryptocurrency users, its creation can cause a greater negative impact on the environment, especially if the demand for obtaining Monero increases (ibid).

On the other hand, a study by McCook has shown that Bitcoin seems to be more environmentally friendly and less costly than the issuing of paper money, banking

systems, and gold mining (McCook, 2014). A research conducted by the CoolClimate Network from the University of California, Berkeley and cited by Cocco et al. has shown that the total CO_2impact of the banking sector amounts to 387 million tons, meanwhile Bitcoin produces only 0.75 million tons, making it a lot less harmful to the environment (ibid).

The environmental impacts of cryptocurrencies cannot be ignored and the carbon footprints produced by cryptocurrencies should raise the issue of externalities by governments (Badea & Claudia, 2021). On the other hand, the environmental impact of Bitcoin mining (such as the tonnes of CO_2 produced and energy used (GJ)) is smaller than that of the banking system, gold mining and recycling, and paper currency and minting, which indicates why the future of world economies should rely on digital currencies, due to their smaller environmental impact (ibid).

2.3.6 Perceived Risk of Cryptocurrencies

In the Information Systems (IS) industry, risk perception is defined as uncertainty regarding possible negative consequences of using a product or service (Chen & Farkas, 2019). Past studies have shown that the risk perceptions of technology have impacted the adoption of modern technologies, such as e-governments, e-services, and of course, Bitcoin (Abramova & Böhme, 2016). Abramova & Böhme (2016) have identified and analyzed 6 essential risks of Bitcoin, which are market risk, counterparty risk, transaction risk, operational risk, privacy risk, and legal and regulatory risk. Their results have shown that Bitcoin adoption is limited due to its fluctuating value, risk of losing funds due to security breaches and malfunctions, and the lack of consumer protection (ibid). Analyzing the loss of funds due to security breaches or malfunctions, cryptocurrency exchange systems such as BitGO and Coinbase are working with insurance companies to offer cryptocurrency users insurance policies for some security threats, but not all, as it can be difficult for insurance companies to identify cryptocurrency theft (Abramova & Böhme, 2016). Analyzing the need for legal protection of cryptocurrency users, it can be stated that the public want the decentralized cryptocurrencies to be regulated, which would provide user protection and the compliance of cryptocurrencies with the law (ibid). The results of Abramova & Böhme's (2016) study have also shown that users of Bitcoin are concerned about the legal regulations regarding the use of Bitcoin (ibid). Moreover, it showed that

users have a perceived risk of use, as users that are considering adopting Bitcoin believe that Bitcoin is a complicated system and requires a lot of effort (Abramova & Böhme, 2016), however, this can be altered by educating oneself about how the cryptocurrency system works, making the user more comfortable with trading and utilizing cryptocurrencies. Furthermore, the study has shown that decentralization, an attribute that is favored by cryptocurrency users, does not contribute to a benefit of Bitcoin, meaning it is perceived as a risk, because there is no central authority or legal protection for the user (ibid).

Therefore, with all of these factors considered, it seems as if potential users are not willing to adopt cryptocurrencies due to its underlying technology, which cannot always be altered due to its technological elements. To increase cryptocurrency adoption and overcome its perceived risks, users need to educate themselves regarding how cryptocurrency systems function, as well as their aspects on user privacy, security, etc. There exist many cryptocurrencies and systems that focus on privacy and security, such as Monero and Zcash, and Binance and Huobi, therefore, if users become more aware of different cryptocurrencies and their technological attributes, they would be more likely to adopt them.

3 Methodology

3.1 Research Designs

Research approaches are procedures and plans that are used to develop detailed methods of data collection, analysis, and interpretation, which are derived from broad assumptions (Cresswell, 2014). Research approaches have to be chosen based on the nature of the research problem, and what type of information the writer needs to help answer the main research problem (ibid).

When collecting primary data, it is necessary to determine which research design (qualitative, quantitative or mixed methods) will be used (ibid). Qualitative methods are used for the collection and understanding of open-ended and communicational data, through the use of interviews, case studies, ethnographic research, focus groups, etc. (ibid). Quantitative methods are used when testing for objective theories, by identifying the relationships among variables, as well as studying the numerical and

statistical data that is generally collected through surveys or questionnaires (ibid). Mixed methods are the combination of the quantitative and qualitative approach and used to facilitate the process of data interpretation, as well as to have a deeper understanding of the research question (ibid).

3.2 Quantitative Research Design

In order to answer this research question, the quantitative method research design will be used for the collection of the primary data, with the use of two online surveys. A survey design describes numeric or quantitative trends, attitudes, or opinions of a population, which is done by studying a sample of the stated population (Creswell, 2014). When the sample results of the survey are gathered, they are generalized or inferred to the population (ibid). Surveys will be used, as it is easier to obtain and generalize a large amount of data from the audience and use it to obtain a deeper understanding of the perceptions of cryptocurrencies in the eyes of the public, (ibid). Surveys will help to understand what concerns the public regarding the adoption of cryptocurrencies, and what can be done to increase cryptocurrency adoption. This is because the belief in, and adoption of cryptocurrency by the participants of the survey (as well as the rest of the world) are a major influencing factor of the potential growth of cryptocurrency in the future. A key advantage of creating data through surveys is that it can take place virtually through a computer screen, which can help reach a wider audience at a cheaper price. Furthermore, with the current pandemic of COVID-19, it is best to avoid big group gatherings, to avoid the spreading of the virus further. Overall, the quantitative research approach will be best to use in order to answer the main research question of determining how people's cryptocurrency perceptions can be altered.

3.3 Data Collection & Analysis

The online surveys will be the main source of primary data collection for this research paper. The survey will ask the participants questions regarding their perceptions of security, privacy, trust, financial gain, sustainability and perceived risk of cryptocurrencies, as well as try to understand if the participant is a risk taker or not. There are two surveys, a positive one outlining the benefits of using and adopting cryptocurrencies and a negative one outlining the problems of using and adopting

cryptocurrencies. Both surveys will begin with a first set of questions to understand the participants' perceptions on cryptocurrencies, as well as their opinion of whether or not they are risk takers. Following this, the participants will be asked to watch a short self-made video. The video of the positive survey starts off by defining cryptocurrency and stating their main technological attributes and use cases, followed by a discussion of the positive aspects of cryptocurrencies, such as their financial gains, decentralized attributes, and the potential of future growth in price. The video of the negative survey starts off by defining cryptocurrency and stating their main technological attributes and use cases, followed by a discussion of the negative aspects of cryptocurrencies, such as the hacks and thefts, impact of mining on the environment, and the loss of keys and passwords. Following the video, the participants will have to answer a second set of questions, that will be identical to the first, except questions about the participant being a risk taker will be dismissed. This will be done in order to understand how the perceptions of the public change when they are exposed to positive and negative information regarding cryptocurrencies. The questions of the survey are written in English and will be done through the Google Forms online service, which is an easy-to-use and cost-effective online survey platform. The survey began on the 23rd of April 2021 and closed on the 7th of May 2021. The survey was shared by the author's family members and friends, which will provide demographic diversity among the data. After the 100 responses were collected, the survey was closed and the results will be statistically analysed with the R programming language, to help determine if the before and after responses showed a significant difference. Furthermore, a regression analysis will be performed, in order to determine which of the hypotheses was correct. This will depend on the effect that the independent variables will have on the dependent variables, in order to observe a significant or insignificant difference between the variables, which will determine whether or not the hypotheses can be accepted.

3.4 Theoretical Framework & Hypothesis Development

The theoretical framework of this research paper is to identify the factors that influence the perceptions of cryptocurrencies, which are namely security, privacy, financial gain, trust, sustainability, and perceived risks.

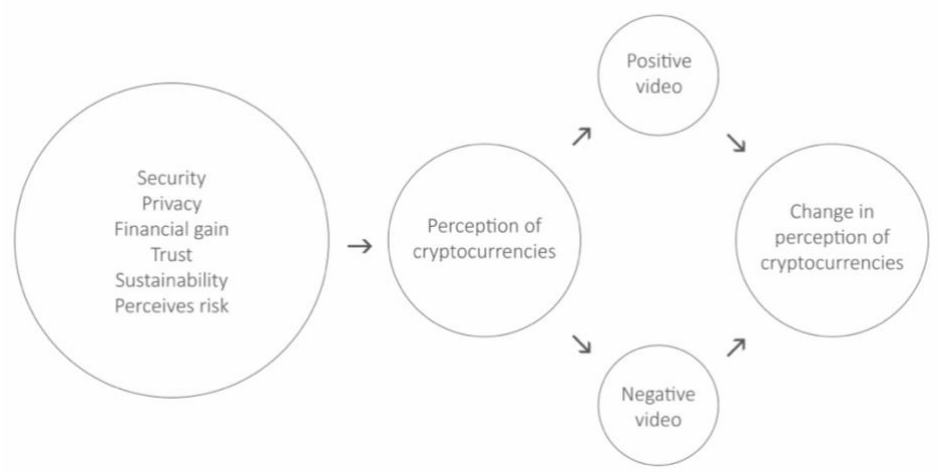

Figure 2.1 - Theoretical framework

The theoretical framework in figure 2.1 displays how security, privacy, financial gain, trust, sustainability, and perceived risk influence the participants' perceptions of cryptocurrencies, and how the positive and negative video should change their perception of cryptocurrencies, either for better or worse. Based on the theoretical framework, these hypotheses will be tested to attempt to answer the main research question

H1: There is a significant difference in the security perceptions of individuals being exposed to positive and negative cryptocurrency information.

H2: There is a significant difference in the privacy perceptions of individuals being exposed to positive and negative cryptocurrency information.

H3: There is a significant difference in the financial gain perceptions of individuals being exposed to positive and negative cryptocurrency information.

H4: There is a significant difference in the trust perceptions of individuals being exposed to positive and negative cryptocurrency information.

H5: There is a significant difference in the sustainability perceptions of individuals being exposed to positive and negative cryptocurrency information.

H6: There is a significant difference in the perceived risk perceptions of individuals being exposed to positive and negative cryptocurrency information.

3.5 Development of Survey

The two surveys used for this research contain the following structure. Each survey has two sections, which include questions regarding demographics, trust, security, privacy, financial gain, sustainability, perceived risk of cryptocurrencies, and the risk assessment of participants (only in section 1 of the survey). The demographics questions ask participants about their age, gender, occupation, whether they own cryptocurrencies, and for how long they own them (if the answer to previous question is yes). Following the demographics section, participants of the survey are asked to state how much they agree with the statement of the question on a 10-point Likert scale, where 1 is *"Totally Disagree"* and 10 is *"Totally Agree"*. The survey questions were originally taken from other research papers and modified to be applicable for this research paper. Following the completion of this section, participants were asked to watch a short video, which is meant to be a stimulus, that outlines positive or negative information about cryptocurrencies. Following the video, participants are asked to answer the same questions from section 1 (except the demographics and participant risk assessment sections), in order to determine how the participants' perceptions regarding cryptocurrencies have changed, following the stimulus.

Below is an outline of how the Google Forms survey was presented to the participants, as well as the additional modifications that were necessary for the applicability of the survey.

Heading:

Cryptocurrency – Bachelor Thesis Survey

Introduction to the survey:

Benefits of Cryptocurrencies:

PLEASE READ:

Here, you will be asked questions regarding your thoughts and perceptions on the benefits of cryptocurrencies. First, please fill out the questions about yourself. Then begin with the questions regarding cryptocurrencies. After you complete the survey,

you will be asked to watch a video. Please watch this video and fill out the survey below the video again (the questions are in fact the same).

Problems of Cryptocurrencies:

PLEASE READ:

Here, you will be asked questions regarding your thoughts and perceptions on the problems of cryptocurrencies. First, please fill out the questions about yourself. Then begin with the questions regarding cryptocurrencies. After you complete the survey, you will be asked to watch a video. Please watch this video and fill out the survey below the video again (the questions are in fact the same).

Survey:

Trust in Cryptocurrencies

Source	Variable	Original Question	Modified Question
(Gil-Cordero et al., 2020)	VAR_2.1	I believe that cryptocurrencies are trustworthy.	Cryptocurrencies are trustworthy.
(Gil-Cordero et al., 2020)	VAR_2.2	Even if they were not regulated, I would still trust cryptocurrencies.	Even if cryptocurrencies are not fully regulated, I still trust them.
(Forsythe et al., 2006)	VAR_2.3	Can't trust the online company	Generally, I trust cryptocurrency exchange systems

Security of Cryptocurrencies

Source	Variable	Original Question	Modified Question
(Nasir et al., 2015)	VAR_3.1	I'm worried about using online banking because other people may be able to access my account.	I am worried about owning cryptocurrency because of its security.
(Nasir et al., 2015)	VAR_3.2	I would not feel secure sending sensitive information through Internet banking.	I feel secure about buying, holding, and transferring cryptocurrency.
(Vrîncianu & Popa, 2010)	VAR_3.3	Internet is secure for conducting financial transactions.	Cryptocurrency is secure for conducting financial transactions.

Privacy of Cryptocurrencies

Source	Variable	Original Question	Modified Question
(Gil-Cordero et al., 2020)	VAR_4.1	I think that the use of cryptocurrencies puts my privacy at risk.	When using cryptocurrencies, my privacy is at risk.
(Nasir et al., 2015)	VAR_4.2	I do not feel totally safe by providing personal privacy information through Internet banking.	I feel safe providing personal privacy information to cryptocurrency exchange systems.

Financial Gain of Cryptocurrencies

Source	Variable	Original Question	Modified Question
-	VAR_5.1	-	I believe cryptocurrencies will increase in value in the future.
(Chatterjee et al., n.d.)	VAR_5.2	Even though it is a little risky, I prefer to invest in the stock market because of the possibility of getting high returns.	Investing into cryptocurrencies will yield a high return on my investment.

Sustainability of Cryptocurrencies

Source	Variable	Original Question	Modified Question
(Arps, 2018)	VAR_6.1	How sustainable is the Bitcoin network in terms of its environmental influence regarding the increasing energy consumption (caused by a growing number and higher hash rate of miners), while ASIC chips getting more and more energy efficient due to Moore's Law?	Cryptocurrencies have the potential to positively contribute to an environmentally friendly and sustainable society.
(Akerlof et al., 2010)	VAR_6.2	When do you think global warming will start to harm people in the United States?	Cryptocurrency mining has a negative impact on humanity.

Perceived Risks of Cryptocurrencies

Source	Variable	Original Question	Modified Question
(Forsythe et al., 2006)	VAR_7.1	Inability to touch and feel the item	I feel at risk since I cannot touch or feel cryptocurrencies.
(Buchanan et al., 2007)	VAR_7.2	Are you concerned that if you use your credit card to buy something on the internet your card will be mischarged?	I am concerned about the potential of my cryptocurrency being stolen.
(Zheng, 2013)	VAR_7.3	Most of the time, I avoid any investment involving risks.	The use of cryptocurrencies exposes me to a general risk.
(Buchanan et al., 2007)	VAR_7.4	Are you concerned about people you do not know obtaining personal information about you from your online activities?	If I use cryptocurrencies, hackers may be able to read my transaction history.

Risk Assessment of Participants

Source	Variable	Original Question	Modified Question
-	VAR_8.1	-	I am a risk taker.
(Markiewicz & Weber, 2013)	VAR_8.2	Are you concerned that if you use your credit card to buy something on the internet your card will be mischarged?	I like to try out new things.
(Loix et al., 2005)	VAR_8.3	I regularly look for interesting investment opportunities for my money.	I am interested in potentially investing into a new asset category.
(Markiewicz & Weber, 2013)	VAR_8.4	I often take risk just for fun	I often take risks just for fun.

3.6 Ethical Considerations

When writing a research paper, it is important to assess and consider the ethical issues that may arise during the experiment. When choosing a quantitative research design and conducting a survey, it is important to consider the information that is being gathered about the participants of the survey and determine how their information can be protected before the survey is issued (Creswell, 2014). Before the survey, the *code of ethics* will be considered (ibid). Before participants will take part in the survey, they will be informed that the responses are anonymous to ensure user data privacy and will be asked to provide their consent for the use and analysis of the data they have provided, following the collection of survey responses (ibid). Participants will not be pressured into giving their consent for the recording, analysis, and use of their data, and will be informed about the purpose of the study (ibid).

4 Data Results & Analysis

In this section the gathered data of the survey will be presented and analyzed, to answer the main research question: *How do people's perceptions change regarding cryptocurrencies, when they are exposed to positive and negative cryptocurrency information?* To answer this research question, a survey was conducted to determine how the participants' perceptions on cryptocurrencies change, when one group is exposed to a positive video, and the other group is exposed to a negative video. The *"Benefits of Cryptocurrency"* (BOC) video can be found in Appendix B and the *"Problems of Cryptocurrency"* (POC) video can be found in Appendix C.

Following the closing of the survey, the following results were gathered. The Google Forms survey was available from the 23rd of April 2021 to the 7th of May 2021, where a total of 100 participants took part in the two surveys (50 participants – benefits of cryptocurrencies; 50 participants – problems of cryptocurrencies). The survey results and analyses can be found in Appendix A, and the t-test results can be found in Appendix D. Table 4.1 below presents the demographics of the participants that took part in both surveys.

Table 4.1 – Demographics of the survey participants

Demographics		Benefits of Cryptocurrencies (BOC)	Problems of Cryptocurrencies (POC)
Participants	100 Total	50 participants (50%)	50 participants (50%)
Gender	Male	35 (70%)	30 (60%)
	Female	15 (30%)	20 (40%)
Age	17-	0 (0%)	0 (0%)
	18-24	24 (48%)	22 (44%)
	25-35	12 (24%)	14 (28%)
	35+	14 (28%)	14 (28%)
Occupation	Student	25 (50%)	27 (54%)
	Employed	25 (50%)	23 (46%)
Own Cryptocurrencies	Yes	30 (60%)	37 (74%)
	No	20 (40%)	13 (26%)
If you own cryptocurrencies, from what year?	2021	4 (13.3%)	6 (16.22%)
	2020	5 (16.67%)	8 (21.62%)
	2019	3 (10%)	2 (5.41%)
	2018	4 (13.3%)	5 (13,51%)
	2017	12 (40%)	13 (35.14%)
	2012-2016	2 (6.67%)	3 (8.11%)

Looking at table 4.1, the following results can be derived from the demographics of the participants of both surveys.

- Most of the survey participants were male (65%), followed by female (35%).
- Most of the survey participants were in the age range of 18–24-year-old (46%), followed by 35+ (28%), and 25-35 (26%).
- Most of the survey participant are students (52%), followed by employees/employers (48%)
- Most of the survey participants own cryptocurrencies (67%) and there are fewer who do not own them (33%)
- Most of the survey participants that own cryptocurrencies have acquired them in the year 2017 (37.3%), followed by 2020 (19.4%), 2021 (14.93%), 2018 (13.43%), 2019 (7.46%), and 2016 or earlier (7.46%).

The survey participants were asked to rate their responses on a Likert scale that ranged from 1 (totally disagree) to 10 (totally agree) for all the questions in the survey. This range was used to have a clearer understanding of how participants' perceptions were influenced, in comparison to shorter ranges (1-5), which make it harder to analyze smaller impacts that the intervention might have on the participants' perceptions. Furthermore, using a Likert scale is more fitting for t-tests, which will be used to analyze the results of the surveys.

4.1 Trust in Cryptocurrencies

This section will analyze the participants' perceptions on trusting and the trustworthiness of cryptocurrencies and their exchange systems and how their survey responses have changed from before and after the intervention. The survey questions that correspond to trusting cryptocurrencies are the same for both surveys and are as follows:

- *Cryptocurrencies are trustworthy (VAR 2.1)*
- *Even if cryptocurrencies are not regulated, I still trust them (VAR 2.2)*
- *Generally, I trust cryptocurrency exchange systems (VAR 2.3)*

A paired t-test is used to determine whether the intervention made a significant difference in the trust perceptions of cryptocurrencies. The t-tests were done individually for each question to determine the differences in trust perceptions.

4.1.1 Cryptocurrencies are trustworthy (VAR 2.1)

The mean value for the question *"cryptocurrencies are trustworthy"* (VAR 2.1) before the intervention for the benefits of cryptocurrency (BOC) group had a mean value of 6.92 and the problems of cryptocurrency group (POC) had 6.8. This indicates that the participants of both survey's perceived cryptocurrency as being trustworthy before the intervention was present.

Following the intervention in the BOC survey, the mean increased from 6.92 to 8.04 (+1.12) and presented a p-value of $1.347e^{-0.5}$, indicating a significant difference. This is a positive change in the perceptions of cryptocurrencies, and implies that following the intervention, the participants perceive cryptocurrencies as being more trustworthy than before. Following the intervention in the POC survey, the mean decreased from 6.8 to 6.26 (-0.54) and presented a p-value of 0.05527, indicating an insignificant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants now believe that cryptocurrencies are less trustworthy than before. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should increase trust meanwhile the POC survey should decrease it and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the BOC intervention had a greater impact than the POC intervention, regarding the participants' perception on cryptocurrencies being trustworthy, as the mean change was higher for BOC than POC.

4.1.2 Even if cryptocurrencies are not regulated, I still trust them (VAR 2.2)

The mean value for the question *"even if cryptocurrencies are not regulated, I still trust them"* (VAR 2.2) before the intervention for the BOC group had a mean value of 6.9 and the POC group had 6.72. This indicates that the participants of both survey's perceived cryptocurrency as being trustworthy, although they are not regulated, before the intervention was present.

Following the intervention in the BOC survey, the mean increased from 6.9 to 7.66 (+0.76) and presented a p-value of 0.001587, indicating a significant difference. This is a positive change in the perceptions of cryptocurrencies, and implies that following the intervention, the participants perceive cryptocurrencies as being more trustworthy, although they are not regulated, than before. Following the intervention in the POC survey, the mean decreased from 6.72 to 6.27 (-0.45) and presented a p-value of 0.192, indicating an insignificant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants now believe that cryptocurrencies are less trustworthy, even if they are not regulated, than before. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should increase trust meanwhile the POC survey should decrease it and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the BOC intervention had a greater impact than the POC intervention, regarding the participants' perception on cryptocurrencies being trustworthy, as the mean change was higher for BOC than POC.

4.1.3 Generally, I trust cryptocurrency exchange systems" (VAR 2.3)

The mean value for the question *"generally, I trust cryptocurrency exchange systems"* (VAR 2.3) before the intervention for the BOC group had a mean value of 6.56 and the POC group had 7. This indicates that the participants of both survey's perceived cryptocurrency as being trustworthy although they are not regulated before the intervention was present.

Following the intervention in the BOC survey, the mean increased from 6.56 to 7.68 (+1.12) and presented a p-value of $8.544e^{-0.5}$, indicating a significant difference. This is a positive change in the perceptions of cryptocurrencies, and implies that following the intervention, the participants perceive cryptocurrency exchange systems as being more trustworthy than before. Following the intervention in the POC survey, the mean decreased from 7 to 6.06 (-0.94) and presented a p-value of 0.01164, indicating a significant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants now believe that cryptocurrency exchange systems are less trustworthy than before. Therefore, the stimulus had the anticipated impact on participants' perceptions as the

BOC survey should increase trust in cryptocurrency exchange systems meanwhile the POC survey should decrease it and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the BOC intervention had a greater impact than the POC intervention, regarding the participants' perception on cryptocurrency exchange systems being trustworthy, as the mean change was higher for BOC than POC.

4.1.4 Trust in Cryptocurrencies Overview

From these 3 questions on trusting cryptocurrencies, it can be derived that most of the participants on average trusted cryptocurrencies and their exchange systems before the survey. Looking at the p-values of the t-tests in the BOC group, it can be stated that all 3 questions (variables) were influenced by the intervention and caused a significant difference in the before and after responses. Looking at the p-values of the t-tests in the POC group, it can be stated that only VAR 2.3 was influenced by the intervention and caused a significant difference in the before and after responses, and VAR 2.1 and 2.2 showed an insignificant difference. There was a significant difference in the changed perceptions following the intervention in the BOC and POC surveys, where the BOC survey had a greater impact on the participants trust perceptions of cryptocurrencies than the POC survey. Overall, before and after the intervention, the participants perceived cryptocurrencies and their exchange systems as being relatively trustworthy and were influenced as expected according to the intervention they were exposed to, and this is presented in figure 4.2 below.

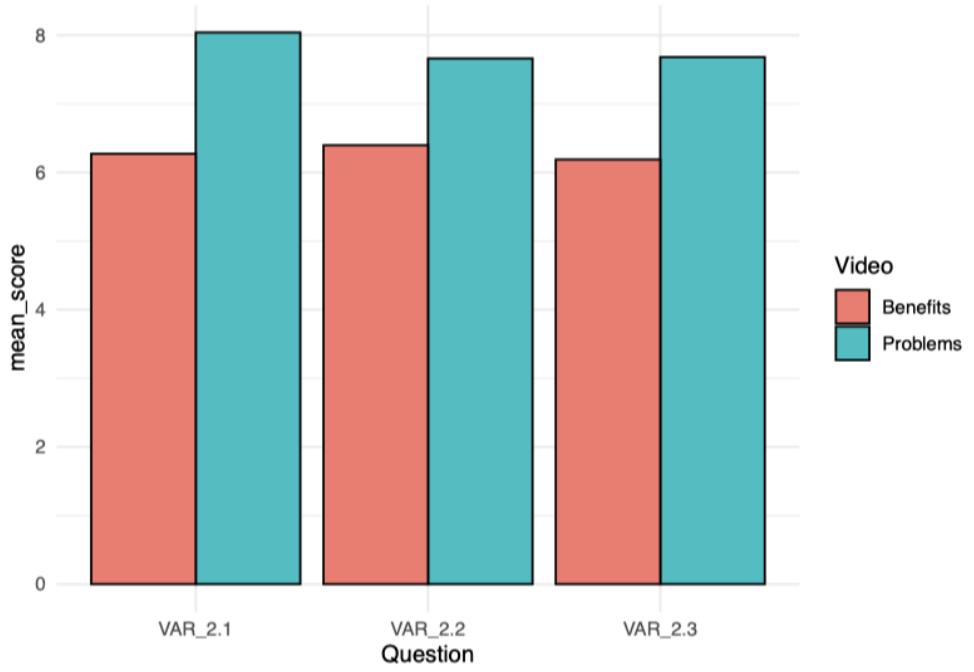

Figure 4.2 – Mean scores of "trust of cryptocurrencies" after the intervention

4.2 Security of Cryptocurrencies

This section will analyze the participants' perceptions on the security of owning and using cryptocurrencies and how their survey responses have changed from before and after the intervention. The survey questions that correspond to the security of cryptocurrencies are the same for both surveys and are as follows:

- *I am worried about owning cryptocurrencies because of its security (VAR 3.1)*
- *I feel secure about buying, holding, and transferring cryptocurrencies (VAR 3.2)*
- *Cryptocurrencies are secure for conducting financial transactions (VAR 3.3)*

A paired t-test is used to determine whether the intervention made a significant difference in the security perceptions of cryptocurrencies. The t-tests were done individually for each question to determine the differences in security perceptions.

4.2.1 I am worried about owning cryptocurrencies because of its security (VAR 3.1)

The mean value for the question "*I am worried about owning cryptocurrencies because of its security"* (VAR 3.1) before the intervention for the BOC group had a mean value of 5.36 and the POC group had 4.52. This indicates that the participants of both surveys are worried about owning cryptocurrencies because of their securities to a notable extent.

Following the intervention in the BOC survey, the mean decreased from 5.36 to 4.56 (-0.8) and presented a p-value of 0.04622, indicating a significant difference. This is a positive change in the perceptions of cryptocurrencies, and implies that following the intervention, the participants are less worried about owning cryptocurrencies due to its security than before. Following the intervention in the POC survey, the mean increased from 4.52 to 5.67 (+1.15) and presented a p-value of 0.01654, indicating a significant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants are more worried about owning cryptocurrencies due to its security than before. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should make participants less worried about owning cryptocurrencies because of its securities meanwhile the POC survey should make participants more worried about owning cryptocurrencies because of its securities and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the POC intervention had a greater impact than the BOC intervention, regarding the participants being worried about owning cryptocurrencies because of its securities as the mean change was higher for POC than BOC.

4.2.2 I feel secure about buying, holding, and transferring cryptocurrencies (VAR 3.2)

The mean value for the question *"I feel secure about buying, holding, and transferring cryptocurrencies"* (VAR 3.2) before the intervention for the BOC group had a mean value of 6.96 and the POC group had 6.88. This indicates that the participants of both surveys feel considerably secure about buying, holding, and transferring cryptocurrencies.

Following the intervention in the BOC survey, the mean increased from 6.96 to 7.5 (+0.54) and presented a p-value of 0.05744, indicating an insignificant difference. This is a positive change in the perceptions of cryptocurrencies, and implies that following the intervention, the participants feel more secure about buying, holding, and transferring cryptocurrencies than before. Following the intervention in the POC survey, the mean decreased from 6.88 to 6.26 (-0.62) and presented a p-value of 0.08742, indicating an insignificant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants feel less secure about buying, holding, and transferring cryptocurrencies than before. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should make participants feel more secure about buying, holding, and transferring cryptocurrencies meanwhile the POC survey should make participants feel less secure about buying, holding, and transferring cryptocurrencies and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the POC intervention had a greater impact than the BOC intervention regarding the participants' perceptions on being secure about buying, holding, and transferring cryptocurrencies as the mean change was higher for POC than BOC.

4.2.3 Cryptocurrencies are secure for conducting financial transactions (VAR 3.3)

The mean value for the question *"cryptocurrencies are secure for conducting financial transactions"* (VAR 3.3) before the intervention for the BOC group had a mean value of 7.32 and the POC group had 7.02. This indicates that the participants of both survey's perceived cryptocurrencies as being considerably secure for conducting financial transactions before the intervention was present.

Following the intervention in the BOC survey, the mean increased from 7.32 to 8.06 (+0.74) and presented a p-value of 0.005003, indicating a significant difference. This is a positive change in the perceptions of cryptocurrencies, and implies that following the intervention, the participants perceive cryptocurrencies as being more secure for conducting financial transactions than before. Following the intervention in the POC survey, the mean decreased from 7.02 to 6.50 (-0.52) and presented a p-value of 0.1074, indicating an insignificant difference. This is a negative change in the

perceptions of cryptocurrencies and implies that following the intervention, the participants perceive cryptocurrencies as being less secure for conducting financial transactions than before. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should make participants perceive cryptocurrencies as being more secure for conducting financial transactions meanwhile the POC survey should make participants perceive cryptocurrencies as being less secure for conducting financial transactions and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the BOC intervention had a greater impact than the POC intervention, regarding the participants' perception on cryptocurrencies being secure for conducting financial transactions, as the mean change was higher for BOC than POC.

4.2.4 Security of Cryptocurrencies Overview

From these 3 questions on the security of cryptocurrencies, it can be derived that most of the participants on average perceived cryptocurrencies as being secure before the survey. Looking at the p-values of the t-tests in the BOC group, it can be stated that VAR 3.1 and VAR 3.3 were significantly influenced by the intervention and caused a significant difference in the before and after responses. Looking at the p-values of the t-tests in the POC group, it can be stated that only VAR 3.1 was influenced by the intervention and caused a significant difference in the before and after responses, and VAR 3.2 and VAR 3.3 showed an insignificant difference. There was a significant difference in the changed perceptions following the intervention in the BOC and POC surveys, where the BOC survey had a greater impact on the participants security perceptions of cryptocurrencies than the POC survey. Overall, before and after the intervention the participants perceived cryptocurrencies as being considerably secure and were influenced as expected according to the intervention they were exposed to, and this is presented in figure 4.3 below.

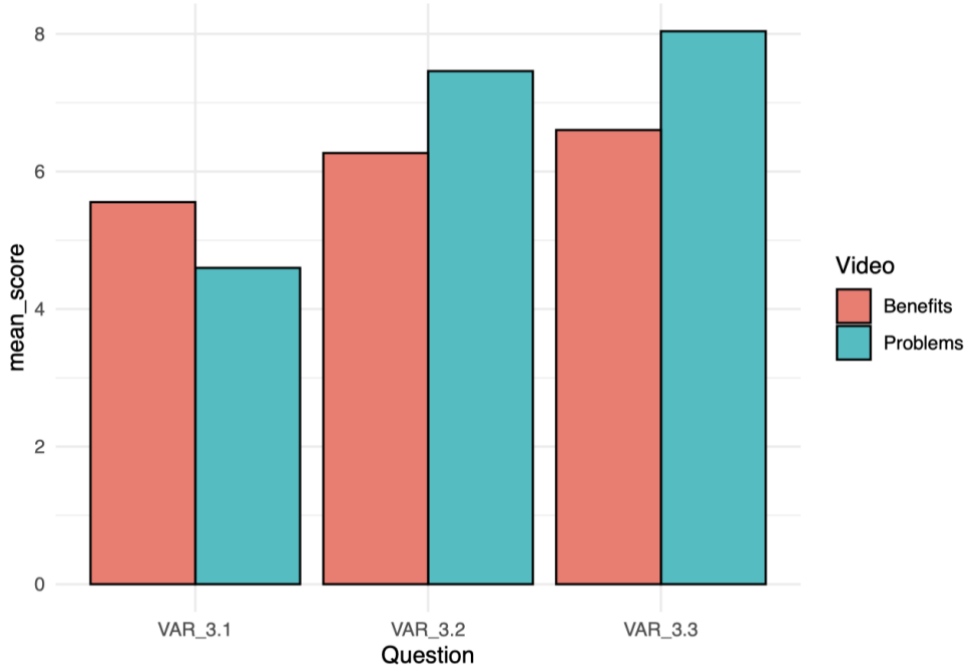

Figure 4.3 - Mean scores of "securities of cryptocurrencies" after the intervention

4.3 Privacy of Cryptocurrencies

This section will analyze the participants' perceptions on the privacy of cryptocurrencies and their exchange systems and how their survey responses have changed from before and after the intervention. The survey questions that correspond to the privacy of cryptocurrencies are the same for both surveys and are as follows:

- *When using cryptocurrencies, my privacy is at risk (VAR 4.1)*
- *I feel safe providing personal privacy information to cryptocurrency exchange systems (VAR 4.2)*

A paired t-test is used to determine whether the intervention made a significant difference in the privacy perceptions of cryptocurrencies. The t-tests were done individually for each question to determine the differences in privacy perceptions.

4.3.1 When using cryptocurrencies, my privacy is at risk (VAR 4.1)

The mean value for the question *"when using cryptocurrencies, my privacy is at risk"* (VAR 4.1) before the intervention for the BOC group had a mean value of 4.54 and the

POC group had 3.98. This indicates that the participants of both surveys perceive their privacy as being at risk when using cryptocurrencies to a lesser extent.

Following the intervention in the BOC survey, the mean decreased from 4.54 to 3.98 (-0.56) and presented a p-value of 0.114, indicating an insignificant difference. This is a positive change in the perceptions of cryptocurrencies and implies that following the intervention, the participants perceive their privacy as being exposed to less risk when using cryptocurrencies than before. Following the intervention in the POC survey, the mean increased from 3.98 to 5.71 (+1.73) and presented a p-value of 0.0006601, indicating a significant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants perceive their privacy as being exposed to more risk when using cryptocurrencies than before. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should make participants perceive their privacy as being at less risk when using cryptocurrencies meanwhile the POC survey should make participants perceive their privacy as being at more risk when using cryptocurrencies and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the POC intervention had a greater impact than the BOC intervention, regarding the participants privacy being at risk when using cryptocurrencies as the mean change was higher for POC than BOC.

4.3.2 I feel safe providing personal privacy information to cryptocurrency exchange systems (VAR 4.2)

The mean value for the question *"I feel safe providing personal privacy information to cryptocurrency exchange systems"* (VAR 4.2) before the intervention for the BOC group had a mean value of 5.88 and the POC group had 5.82. This indicates that the participants of both surveys feel moderately safe providing personal privacy information to cryptocurrency exchange systems.

Following the intervention in the BOC survey, the mean increased from 5.88 to 5.96 (+0.08) and presented a p-value of 0.9001, indicating an insignificant difference. This is a positive change in the perceptions of cryptocurrencies and implies that following the intervention, the participants feel safer providing personal information to cryptocurrency exchange systems than before. Following the intervention in the POC

survey, the mean decreased from 5.82 to 5.21 (-0.61) and presented a p-value of 0.1096, indicating an insignificant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants feel less feel safe providing personal information to cryptocurrency exchange systems than before. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should make participants feel safer when providing personal information to cryptocurrency exchange systems, meanwhile the POC survey should make participants feel less safe when providing personal information to cryptocurrency exchange systems and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the POC intervention had a greater impact than the BOC intervention regarding the participants' perceptions on feeling safe providing personal information to cryptocurrency exchange systems than before as the mean change was higher for POC than BOC.

4.3.3 Privacy of Cryptocurrencies Overview

From these 2 questions on the privacy of cryptocurrencies, it can be derived that most of the participants on average perceived cryptocurrencies as having a considerable level of privacy before the survey. Looking at the p-values of the t-tests in the BOC group, it can be stated that none of the variables were significantly influenced by the intervention, therefore, caused an insignificant difference in all of the before and after responses. Looking at the p-values of the t-tests in the POC group, it can be stated that only VAR 4.1 was influenced by the intervention and caused a significant difference in the before and after responses, and VAR 4.2 showed an insignificant difference. There was a significant difference in the changed perceptions following the intervention in the POC survey, where the POC survey had a greater impact on the participants privacy perceptions of cryptocurrencies than the BOC survey. Overall, before and after the intervention the participants perceived cryptocurrencies as having considerably privacy and were influenced as expected according to the intervention they were exposed to, and this is presented in figure 4.4 below.

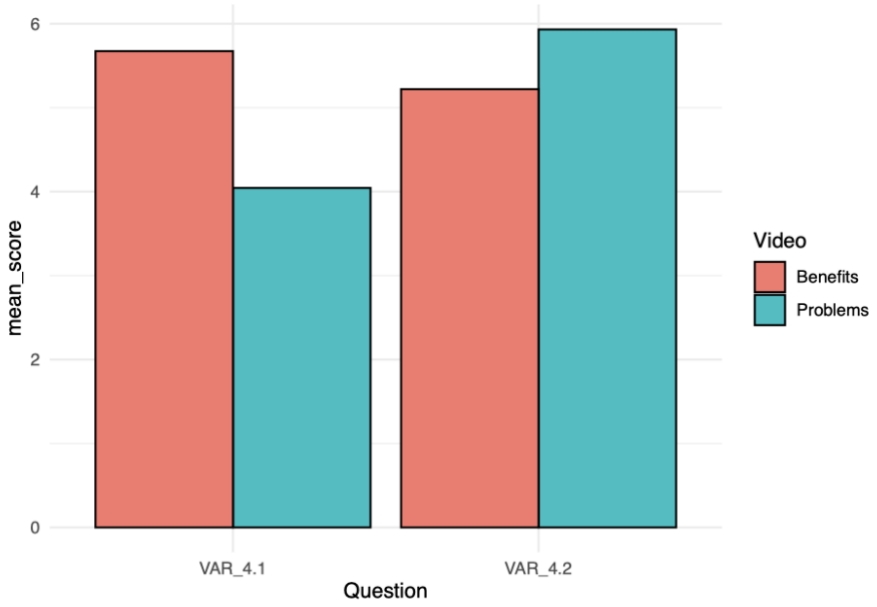

Figure 4.4 - Mean scores of "privacy of cryptocurrencies" after the intervention

4.4 Financial Gain of Cryptocurrencies

This section will analyze the participants' perceptions on the financial gains of cryptocurrencies and how their survey responses have changed from before and after the intervention. The survey questions that correspond to the financial gains of cryptocurrencies are the same for both surveys and are as follows:

- *I believe cryptocurrencies will increase in value in the future (VAR 5.1)*
- *Investing into cryptocurrencies will yield a high return on my investment (VAR 5.2)*

A paired t-test is used to determine whether the intervention made a significant difference in the financial gain perceptions of cryptocurrencies. The t-tests were done individually for each question to determine the differences in financial gain perceptions.

4.4.1 I believe cryptocurrencies will increase in value in the future (VAR 5.1)

The mean value for the question *"I believe cryptocurrencies will increase in value in the future"* (VAR 5.1) before the intervention for the BOC group had a mean value of

8.3 and the POC group had 8.15. This indicates that the participants of both surveys believe that cryptocurrencies will increase in value in the future to a greater extent.

Following the intervention in the BOC survey, the mean increased from 8.3 to 8.62 (+0.32) and presented a p-value of 0.2774, indicating an insignificant difference. This is a positive change in the perceptions of cryptocurrencies and implies that following the intervention, the participants believe that cryptocurrencies will increase in value in the future, more than they did before conducting the survey. Following the intervention in the POC survey, the mean decreased from 8.15 to 7.90 (-0.25) and presented a p-value of 0.1055, indicating an insignificant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants believe that cryptocurrencies will not increase in value in the future, more than they did before conducting the survey. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should make participants believe that cryptocurrencies will increase in value in the future meanwhile the POC survey should make participants believe that cryptocurrencies will not increase in value in the future and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the BOC intervention had a greater impact than the POC intervention, regarding the participants belief in the future value of cryptocurrencies as the mean change was higher for BOC than POC.

4.4.2 Investing into cryptocurrencies will yield a high return on my investment (VAR 5.2)

The mean value for the question *"investing into cryptocurrencies will yield a high return on my investment"* (VAR 5.2) before the intervention for the BOC group had a mean value of 7.6 and the POC group had 7.96. This indicates that the participants of both surveys believe that investing into cryptocurrencies will yield them a high return on their investment to a greater extent.

Following the intervention in the BOC survey, the mean increased from 7.6 to 8.12 (+0.52) and presented a p-value of 0.01781, indicating a significant difference. This is a positive change in the perceptions of cryptocurrencies and implies that following the intervention, the participants believe that cryptocurrencies will yield them a high

return on their investment more than they did before conducting the survey. Following the intervention in the POC survey, the mean decreased from 7.96 to 7.7 (-0.19) and presented a p-value of 0.5043, indicating an insignificant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants believe that cryptocurrencies will yield them a high return on their investment less than before conducting the survey. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should make participants believe that cryptocurrencies will yield them a high return on their investment meanwhile the POC survey should make participants believe that cryptocurrencies will not yield them a high return on their investment and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the BOC intervention had a greater impact than the POC intervention regarding the participants believing that cryptocurrencies will yield them a high return on their investment as the mean change was higher for BOC than POC.

4.4.3 Financial Gains of Cryptocurrencies Overview

From these 2 questions on the financial gains of cryptocurrencies, it can be derived that most of the participants on average perceived that it is possible to make financial gains from cryptocurrencies and that they will increase in value in the future, before taking part in the survey. Looking at the p-values of the t-tests in the BOC group, it can be stated that only VAR 5.2 was significantly influenced by the intervention and caused a significant difference in the before and after responses. Looking at the p-values of the t-tests in the POC group, it can be stated that none of the variables were significantly influenced by the intervention, therefore, caused an insignificant difference in all the before and after responses. There was a significant difference in the changed perceptions following the intervention in the BOC survey, where the BOC survey had a greater impact on the participants financial gain perceptions of cryptocurrencies than the POC survey. Overall, before and after the intervention the participants perceived that it is possible to make financial gains from cryptocurrencies and that they will increase in value in the future and were influenced as expected according to the intervention they were exposed to, and this is presented in figure 4.5

below.

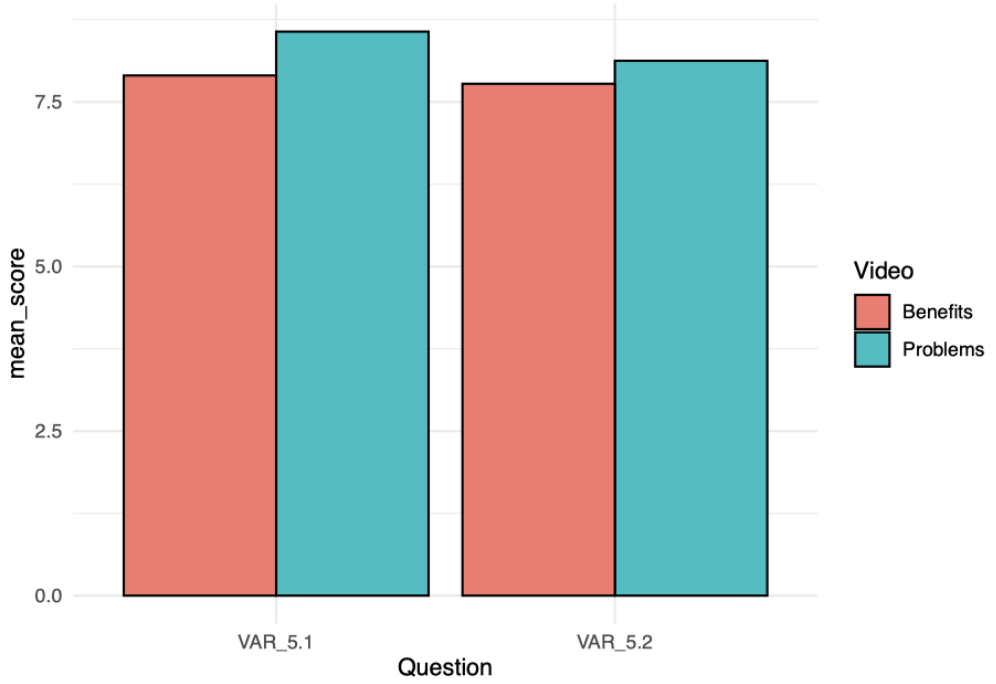

Figure 4.5 - Mean scores of "financial gain of cryptocurrencies" after the intervention

4.5 Sustainability of Cryptocurrencies

This section will analyze the participants' perceptions on the sustainability of cryptocurrencies and how their survey responses have changed from before and after the intervention. The survey questions that correspond to the sustainability of cryptocurrencies are the same for both surveys and are as follows:

- *Cryptocurrencies have the potential to positively contribute to an environmentally friendly and sustainable society (VAR 6.1)*
- *Cryptocurrency mining has a negative impact on humanity (VAR 6.2)*

A paired t-test is used to determine whether the intervention made a significant difference in the sustainability perceptions of cryptocurrencies. The t-tests were done individually for each question to determine the differences in sustainability perceptions.

4.5.1 Cryptocurrencies have the potential to positively contribute to an environmentally friendly and sustainable society (VAR 6.1)

The mean value for the question *"cryptocurrencies have the potential to positively contribute to an environmentally friendly and sustainable society"* (VAR 6.1) before the intervention for the BOC group had a mean value of 6.72 and the POC group had 7.34. This indicates that the participants of both surveys believe that cryptocurrencies have the potential to positively contribute to an environmentally friendly and sustainable society to a greater extent.

Following the intervention in the BOC survey, the mean increased from 6.72 to 7.34 (+0.62) and presented a p-value of 0.0356, indicating a significant difference. This is a positive change in the perceptions of cryptocurrencies and implies that following the intervention, the participants believe that cryptocurrencies have the potential to positively contribute to an environmentally friendly and sustainable society more than they did before conducting the survey. Following the intervention in the POC survey, the mean decreased from 7.34 to 6.02 (-1.32) and presented a p-value of 0.003532, indicating a significant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants believe that cryptocurrencies have the potential to positively contribute to an environmentally friendly and sustainable society less than they did before conducting the survey. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should make participants believe that cryptocurrencies will positively contribute to an environmentally friendly and sustainable society meanwhile the POC survey should make participants believe that cryptocurrencies will negatively contribute to an environmentally friendly and sustainable society and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the POC intervention had a greater impact than the BOC intervention, regarding the participants' perception in that cryptocurrencies have the potential to positively contribute to an environmentally friendly and sustainable society as the mean change was higher for POC than BOC.

4.5.2 Cryptocurrency mining has a negative impact on humanity (VAR 6.2)

The mean value for the question *"cryptocurrency mining has a negative impact on humanity"* (VAR 6.2) before the intervention for the BOC group had a mean value of 5.52 and the POC group had 4.52. This indicates that the participants of both surveys believe that cryptocurrency mining does have a negative impact on humanity to a noteworthy extent.

Following the intervention in the BOC survey, the mean decreased from 5.52 to 5.30 (-0.22) and presented a p-value of 0.5093, indicating an insignificant difference. This is a positive change in the perceptions of cryptocurrencies and implies that following the intervention, the participants believe that cryptocurrency mining has a more positive impact on humanity than before. Following the intervention in the POC survey, the mean increased from 4.52 to 5.75 (+1.23) and presented a p-value of 0.004279, indicating a significant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants believe that cryptocurrency mining has a larger negative impact on humanity than before. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should make participants believe that cryptocurrency mining has a positive impact on humanity meanwhile the POC survey should make participants believe that cryptocurrency mining has a larger negative impact on humanity and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the POC intervention had a greater impact than the BOC intervention regarding the participants believing that cryptocurrency mining has a negative impact on humanity as the mean change was higher for POC than BOC.

4.5.3 Sustainability of Cryptocurrencies Overview

From these 2 questions on the sustainability of cryptocurrencies, it can be derived that most of the participants on average perceived that cryptocurrency is sustainable to a greater extent before taking part in the survey. Looking at the p-values of the t-tests in the BOC group, it can be stated that only VAR 6.1 was significantly influenced by the intervention and caused a significant difference in the before and after responses. Looking at the p-values of the t-tests in the POC group, it can be stated

that both VAR 6.1 and VAR 6.2 were significantly influenced by the intervention, therefore causing a significant difference in the before and after responses. There was a significant difference in the changed perceptions following the intervention in the POC survey, where the POC survey had a greater impact on the participants sustainability perceptions of cryptocurrencies than the BOC survey, as the POC intervention caused a significant difference in both questions. Overall, before and after the intervention the participants perceived cryptocurrencies as being sustainable and were influenced as expected according to the intervention they were exposed to, and this is presented in figure 4.6 below.

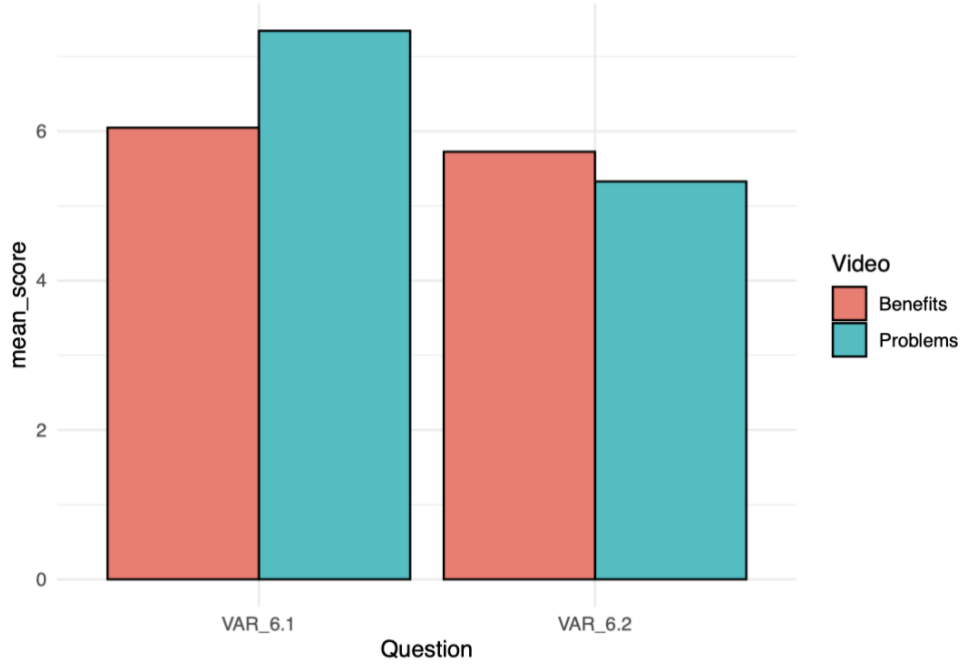

Figure 4.6 - Mean scores of "sustainability of cryptocurrencies" after the intervention

4.6 Perceived Risks of Cryptocurrencies

This section will analyze the participants' perceptions on the perceived risks of cryptocurrencies and how their survey responses have changed from before and after the intervention. The survey questions that correspond to the perceived risks of cryptocurrencies are the same for both surveys and are as follows:

- *I feel at risk since I cannot touch or feel cryptocurrencies (VAR 7.1)*
- *I am concerned about the potential of my cryptocurrency being stolen (VAR 7.2)*
- *The use of cryptocurrencies exposes me to a general risk (VAR 7.3)*
- *If I use cryptocurrencies, hackers may be able to read my transaction history (VAR 7.4)*

A paired t-test is used to determine whether the intervention made a significant difference in the perceived risk perceptions of cryptocurrencies. The t-tests were done individually for each question to determine the differences in perceived risk perceptions.

4.6.1 I feel at risk since I cannot touch or feel cryptocurrencies (VAR 7.1)

The mean value for the question *"I feel at risk since I cannot touch or feel cryptocurrencies"* (VAR 7.1) before the intervention for the BOC group had a mean value of 3.84 and the POC group had 4. This indicates that the participants of both surveys do not feel at risk because they cannot touch or feel cryptocurrencies to a greater extent.

Following the intervention in the BOC survey, the mean decreased from 3.84 to 3.44 (-0.4) and presented a p-value of 0.3183, indicating an insignificant difference. This is a positive change in the perceptions of cryptocurrencies and implies that following the intervention, the participants feel at less risk that they cannot touch or feel cryptocurrencies, more than they did before conducting the survey. Following the intervention in the POC survey, the mean increased from 4 to 4.85 (+0.85) and presented a p-value of 0.07416, indicating an insignificant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants feel at more risk as they cannot touch or feel cryptocurrencies, more than they did before conducting the survey. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should make participants feel at less risk as they cannot touch or feel cryptocurrencies, meanwhile the POC survey should make participants feel at more risk as they cannot touch or feel cryptocurrencies and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the POC

intervention had a greater impact than the BOC intervention, regarding the participants feeling at risk as they cannot touch or feel cryptocurrencies as the mean change was higher for POC than BOC.

4.6.2 I am concerned about the potential of my cryptocurrency being stolen (VAR 7.2)

The mean value for the question *"I am concerned about the potential of my cryptocurrency being stolen"* (VAR 7.2) before the intervention for the BOC group had a mean value of 5.24 and the POC group had 5.81. This indicates that the participants of both surveys are concerned about their cryptocurrency being stolen to a noteworthy extent.

Following the intervention in the BOC survey, the mean decreased from 5.24 to 4.54 (-0.7) and presented a p-value of 0.04064, indicating a significant difference. This is a positive change in the perceptions of cryptocurrencies and implies that following the intervention, the participants are less concerned about the potential of their cryptocurrency being stolen than before. Following the intervention in the POC survey, the mean increased from 5.81 to 6.94 (+1.13) and presented a p-value of 0.002621, indicating a significant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants are more concerned about the potential of their cryptocurrency being stolen than before. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should make participants less concerned about the potential of their cryptocurrency being stolen meanwhile the POC survey should make participants more concerned about the potential of their cryptocurrency being stolen and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the POC intervention had a greater impact than the BOC intervention regarding the participants being concerned about the potential of their cryptocurrency being stolen as the mean change was higher for POC than BOC.

4.6.3 The use of cryptocurrencies exposes me to a general risk (VAR 7.3)

The mean value for the question *"the use of cryptocurrencies exposes me to a general risk"* (VAR 7.3) before the intervention for the BOC group had a mean value of 4.88

and the POC group had 5.56. This indicates that the participants of both surveys believe that the use of cryptocurrencies somewhat exposes them to a general risk.

Following the intervention in the BOC survey, the mean decreased from 4.88 to 4.26 (-0.62) and presented a p-value of 0.048, indicating a significant difference. This is a positive change in the perceptions of cryptocurrencies and implies that following the intervention, the participants believe that the use of cryptocurrencies exposes them to a smaller general risk than before. Following the intervention in the POC survey, the mean increased from 5.56 to 6.79 (+1.23) and presented a p-value of 0.0009264, indicating a significant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants believe that the use of cryptocurrencies exposes them to a bigger general risk than before. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should make participants believe that the use of cryptocurrencies exposes them to a smaller general risk, meanwhile the POC survey should make participants believe that the use of cryptocurrencies exposes them to a bigger general risk and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the POC intervention had a greater impact than the BOC intervention regarding the participants believing that the use of cryptocurrencies exposes them to a general risk as the mean change was higher for POC than BOC.

4.6.4 If I use cryptocurrencies, hackers may be able to read my transaction history (VAR 7.4)

The mean value for the question *"if I use cryptocurrencies, hackers may be able to read my transaction history"* (VAR 7.4) before the intervention for the BOC group had a mean value of 5.2 and the POC group had 5.17. This indicates that the participants of both surveys believe that if they use cryptocurrencies, hackers may be able to read their transaction history to a noteworthy extent.

Following the intervention in the BOC survey, the mean decreased from 5.2 to 4.28 (-0.92) and presented a p-value of 0.01278, indicating a significant difference. This is a positive change in the perceptions of cryptocurrencies and implies that following the intervention, the participants believe that if they use cryptocurrencies, they are less vulnerable to hackers being able to read their transaction history than they did before

participating in the survey. Following the intervention in the POC survey, the mean increased from 5.17 to 5.58 (+0.42) and presented a p-value of 0.1845, indicating an insignificant difference. This is a negative change in the perceptions of cryptocurrencies and implies that following the intervention, the participants believe that if they use cryptocurrencies, they are more vulnerable to hackers being able to read their transaction history than they did before participating in the survey. Therefore, the stimulus had the anticipated impact on participants' perceptions as the BOC survey should make participants believe that if they use cryptocurrencies, they are less vulnerable to hackers being able to read their transaction history, meanwhile the POC survey should make participants believe that if they use cryptocurrencies, they are more vulnerable to hackers being able to read their transaction history and the results show that the intervention influenced the participants' perceptions as expected. Therefore, the BOC intervention had a greater impact than the POC intervention regarding the participants believing that if they use cryptocurrencies, hackers can read their transaction history, as the mean change was higher for BOC than POC.

4.6.5 Perceived Risk of Cryptocurrencies Overview

From these 4 questions on the perceived risks of cryptocurrencies, it can be derived that most of the participants on average were not very concerned with the stated risks of cryptocurrencies before taking part in the survey. Looking at the p-values of the t-tests in the BOC group, it can be stated that VAR 7.2, VAR 7.3, and VAR 7.4 were significantly influenced by the intervention and caused a significant difference in the before and after responses. Looking at the p-values of the t-tests in the POC group, it can be stated that VAR 7.2 and VAR 7.3 were significantly influenced by the intervention, therefore causing a significant difference in the before and after responses. There was a significant difference in the changed perceptions following the intervention in the BOC survey, where the BOC survey had a greater impact on the participants perceived risks of cryptocurrencies than the POC survey, as the BOC intervention caused a significant difference in more questions than the POC survey. Overall, before and after the intervention the participants did not perceive the stated risks of cryptocurrencies as determining factors in adopting and using

cryptocurrencies and were influenced as expected according to the intervention they were exposed to, and this is presented in figure 4.7 below.

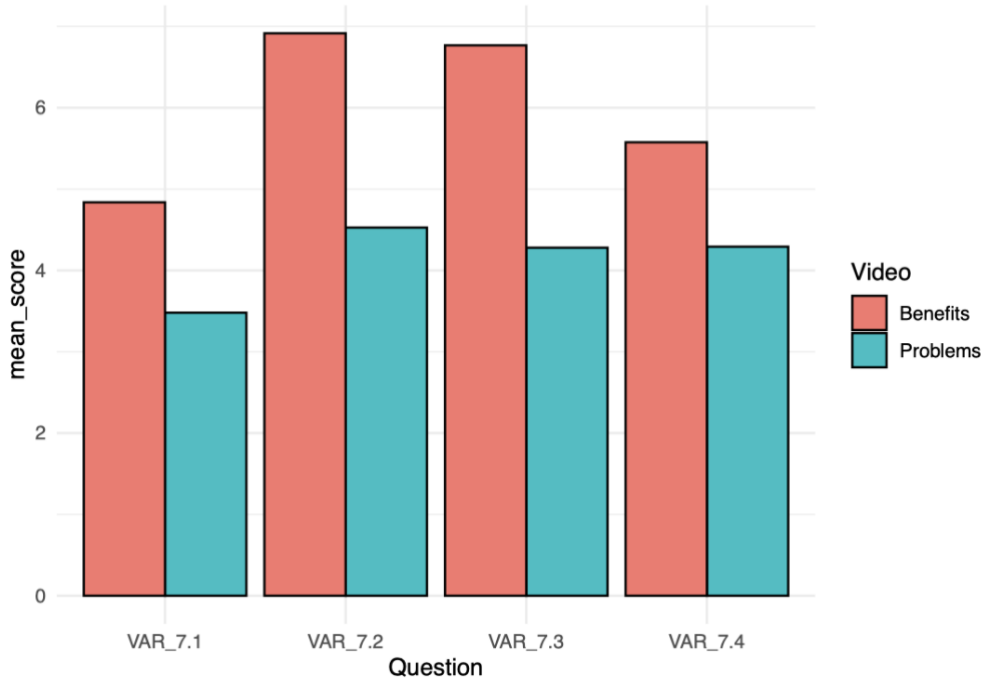

Figure 4.7 - Mean scores of “perceived risks of cryptocurrencies” after the intervention

5 Conclusion

5.1 Outcomes, Limitations, and Recommendations

The purpose of this thesis was to investigate how participants' perceptions on cryptocurrencies change when they are exposed to positive and negative cryptocurrency information. Following the analysis of the survey results it can be stated that several of the participants' perceptions on cryptocurrencies were altered after they were exposed to positive and negative cryptocurrency information. Table 5.1 presents which of the variables and hypotheses showed a significant difference in the benefits and problems experimental settings.

Table 5.1 – Significantly impacted variables of the surveys

Variable & Hypothesis	VAR	Benefits of Cryptocurrencies Survey	Problems of Cryptocurrencies Survey
Trust (H1)	2.1	**Significant**	
	2.2	**Significant**	
	2.3	**Significant**	**Significant**
Security (H2)	3.1	**Significant**	**Significant**
	3.2		
	3.3	**Significant**	
Privacy (H3)	4.1		**Significant**
	4.2		
Financial Gain (H4)	5.1		
	5.2	**Significant**	
Sustainability (H5)	6.1	**Significant**	**Significant**
	6.2		**Significant**
	7.1		

Perceived Risk (H6)	7.2	**Significant**	**Significant**
	7.3	**Significant**	**Significant**
	7.4	**Significant**	

Looking at the results from table 5.1, the hypothesis testing has shown a significant difference in at least one of the variables per construct. Therefore, it can be stated that the two interventions influenced the participants before and after perceptions on cryptocurrencies for at least one of the variables for each of the 6 hypotheses. Furthermore, 12 out of the 16 variables have shown a significant impact in either survey, which means the perceptions of individuals were significantly altered in 75% of the survey questions.

Regarding the sub-questions stated in the introduction of this thesis, the following can be stated: Using the results from the two surveys, the sub-question *"to what extent is a risk-averse person less likely to invest into cryptocurrency?"* can be answered. This is done by taking the mean responses of the four questions on the participants risk assessment, which are *"I am a risk taker"*, *"I like to try out new things"*, "*I am interested in potentially investing into a new asset category"* and *"I often take risks just for fun"* and comparing them to the responses of the question *"do you own cryptocurrencies?"*. The results show that participants that own cryptocurrencies have a risk assessment average of 7.26/10 (1-totally disagree, 10-totally agree), meanwhile the participants that do not own cryptocurrencies have shown a risk assessment average of 6.67. From this, it can be derived that a risk averse person is less likely to invest into cryptocurrencies, when compared to a person that takes more risks. A possible explanation for this is that persons that have previously invested into cryptocurrencies consider themselves as being less risk-averse, which makes them more likely to invest into new assets, meanwhile a participant that has not invested into cryptocurrencies is less likely to invest into new assets. Therefore, a risk-averse person is less likely to invest into cryptocurrencies to a greater extent.

Using the results from the two surveys, the sub-question *"does gender impact the likelihood to invest into cryptocurrency?"* can be answered. This is done by considering the genders of the survey participants (male or female) and determining how many

own cryptocurrencies and how many do not. The results for females show that out of the 35 females that participated in the survey, only 14 of them owned cryptocurrencies (40%). The result for males has shown that out of the 65 males that participated in the survey, 53 of them owned cryptocurrencies (81.5%). Therefore, these results indicate that gender might have an impact on the likelihood of a person investing into cryptocurrencies, where males are currently more likely to invest into cryptocurrencies than females.

Using the results from the two surveys, the sub-question *"to what extent do perceived cryptocurrency risks differ between a person with no cryptocurrency experience and a person with previous cryptocurrency experience?"* can be answered. This is done by considering the participants that own cryptocurrencies and the ones that do not, and looking at the mean responses to the perceived risks of cryptocurrencies survey questions *"I feel at risk since I cannot touch or feel cryptocurrencies", "I am concerned about the potential of my cryptocurrency being stolen", the use of cryptocurrencies exposes me to a general risk",* and *"if I use cryptocurrencies, hackers may be able to read my transaction history"*. The results show that, on average, participants that own cryptocurrencies perceive them with fewer risks and show an average of 4.52, meanwhile the participants that do not own cryptocurrencies perceive them with more risks and have shown an average of 5.81. Therefore, it can be stated that perceived risks differ between a person with no cryptocurrency experience and a person with cryptocurrency experience to a greater extent, as users with no cryptocurrency experience perceive cryptocurrencies as being of higher risk when compared to users with previous cryptocurrency experience. A possible explanation for this is that users that have experience with cryptocurrencies are more knowledgeable about the risks and attributes of cryptocurrencies, meanwhile users that have no previous experience with cryptocurrencies perceive them as being riskier, due to less knowledge of their risks and attributes.

Although this thesis has shown how peoples' perceptions of cryptocurrencies can be altered when they are exposed to positive and negative cryptocurrency information, there were several limitations that could have influenced the findings of this paper, which should be considered in further research and will be briefly described. Firstly, 67% of the survey participants owned cryptocurrencies or have had experience with

them in the past. The participants that already had previous experience with cryptocurrencies are more likely to not be as influenced by the intervention, as they have assessed the risks of cryptocurrencies before adopting them, meanwhile participants that did not previously own cryptocurrencies, nor had any previous experience with them are more likely to be influenced by the intervention, due to the lack of knowledge of cryptocurrencies and their attributes. Therefore, future research should focus on having fewer participants owning cryptocurrencies, to determine how the cryptocurrency perceptions of less-knowledgeable participants can be impacted. Secondly, this thesis did not determine which of the participants' perceptions (variables) were impacted the most by the intervention. This can be done with the use of a power-test, which would identify which variable shows the greatest significant difference in the before and after perceptions and should be considered in future research. Thirdly, the sample size of 100 participants is relatively small when attempting to analyze changes in perceptions, as a larger and more representative sample size would eliminate outliers, provide more accurate data, leading to a better understanding of how people's perceptions of cryptocurrencies can be altered.

List of Abbreviations

BOC – Benefits of Cryptocurrencies

POC – Problems of Cryptocurrencies

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Appendices

Appendix A: Excel file containing analysis and results of the survey responses

https://www.dropbox.com/scl/fi/twlr9k4nb4j86og3xiiyq/BT-Final-Survey-Results.xlsx?dl=0&rlkey=4jzacqaqca2h4yf015t6ix606

Appendix B: Benefits of Cryptocurrencies (intervention video)

https://youtu.be/nTo4iQYQuPs

Appendix C: Problems of Cryptocurrencies (intervention video)

https://youtu.be/5-UO1t5EU90

Appendix D: T-test of survey results

Problems of cryptocurrencies: effect before vs after

VAR_2.1

```
pander(t.test(paired = T, p$VAR_2.1_b, p$VAR_2.1_a))
```

Table 1: Paired t-test: p$VAR_2.1_b and p$VAR_2.1_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
1.966	47	0.05527	two.sided	0.6458

VAR_2.2

```
pander(t.test(paired = T, p$VAR_2.2_b, p$VAR_2.2_a))
```

Table 2: Paired t-test: p$VAR_2.2_b and p$VAR_2.2_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
1.323	49	0.192	two.sided	0.38

VAR_2.3

```
# Significant difference
pander(t.test(paired = T, p$VAR_2.3_b, p$VAR_2.3_a))
```

Table 3: Paired t-test: p$VAR_2.3_b and p$VAR_2.3_a (continued below)

Test statistic	df	P value	Alternative hypothesis
2.621	49	0.01164 *	two.sided

mean of the differences
0.86

VAR_3.1

```
# Significant difference
pander(t.test(paired = T, p$VAR_3.1_b, p$VAR_3.1_a))
```

Table 5: Paired t-test: p$VAR_3.1_b and p$VAR_3.1_a (continued below)

Test statistic	df	P value	Alternative hypothesis
-2.482	49	0.01654 *	two.sided

mean of the differences
-0.96

VAR_3.2

```
pander(t.test(paired = T, p$VAR_3.2_b, p$VAR_3.2_a))
```

Table 7: Paired t-test: p$VAR_3.2_b and p$VAR_3.2_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
1.745	48	0.08742	two.sided	0.5918

VAR_3.3

```
pander(t.test(paired = T, p$VAR_3.3_b, p$VAR_3.3_a))
```

Table 8: Paired t-test: p$VAR_3.3_b and p$VAR_3.3_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
1.64	49	0.1074	two.sided	0.42

VAR_4.1

```
pander(t.test(paired = T, p$VAR_4.1_b, p$VAR_4.1_a))
```

Table 9: Paired t-test: p$VAR_4.1_b and p$VAR_4.1_a (continued below)

Test statistic	df	P value	Alternative hypothesis
-3.638	49	0.0006601 * * *	two.sided

mean of the differences
-1.58

VAR_4.2

```
# Significant difference
pander(t.test(paired = T, p$VAR_4.2_b, p$VAR_4.2_a))
```

Table 11: Paired t-test: p$VAR_4.2_b and p$VAR_4.2_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
1.629	49	0.1096	two.sided	0.66

VAR_5.1

```
pander(t.test(paired = T, p$VAR_5.1_b, p$VAR_5.1_a))
```

Table 12: Paired t-test: p$VAR_5.1_b and p$VAR_5.1_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
1.65	47	0.1055	two.sided	0.4167

VAR_5.2

```
pander(t.test(paired = T, p$VAR_5.2_b, p$VAR_5.2_a))
```

Table 13: Paired t-test: p$VAR_5.2_b and p$VAR_5.2_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
0.6726	49	0.5043	two.sided	0.18

VAR_6.1

```
# Significant difference
pander(t.test(paired = T, p$VAR_6.1_b, p$VAR_6.1_a))
```

Table 14: Paired t-test: `p$VAR_6.1_b` and `p$VAR_6.1_a` (continued below)

Test statistic	df	P value	Alternative hypothesis
3.065	49	0.003532 * *	two.sided

mean of the differences
1.2

VAR_6.2

```
# Significant difference
pander(t.test(paired = T, p$VAR_6.2_b, p$VAR_6.2_a))
```

Table 16: Paired t-test: `p$VAR_6.2_b` and `p$VAR_6.2_a` (continued below)

Test statistic	df	P value	Alternative hypothesis
-2.996	49	0.004279 * *	two.sided

mean of the differences
-1.12

VAR_7.1

```
pander(t.test(paired = T, p$VAR_7.1_b, p$VAR_7.1_a))
```

Table 18: Paired t-test: `p$VAR_7.1_b` and `p$VAR_7.1_a`

Test statistic	df	P value	Alternative hypothesis	mean of the differences
-1.825	49	0.07416	two.sided	-0.82

VAR_7.2

```
# Significant difference
pander(t.test(paired = T, p$VAR_7.2_b, p$VAR_7.2_a))
```

Table 19: Paired t-test: `p$VAR_7.2_b` and `p$VAR_7.2_a` (continued below)

Test statistic	df	P value	Alternative hypothesis
-3.171	49	0.002621 * *	two.sided

mean of the differences
-1.08

VAR_7.3

```
# Significant difference
pander(t.test(paired = T, p$VAR_7.3_b, p$VAR_7.3_a))
```

Table 21: Paired t-test: p$VAR_7.3_b and p$VAR_7.3_a (continued below)

Test statistic	df	P value	Alternative hypothesis
-3.526	49	0.0009264 * * *	two.sided

mean of the differences
-1.18

VAR_7.4

```
pander(t.test(paired = T, p$VAR_7.4_b, p$VAR_7.4_a))
```

Table 23: Paired t-test: p$VAR_7.4_b and p$VAR_7.4_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
-1.346	49	0.1845	two.sided	-0.4

Benefits of cryptocurrencies: effect before vs after

VAR_2.1

```
pander(t.test(paired = T, b$VAR_2.1_b, b$VAR_2.1_a))
```

Table 24: Paired t-test: b$VAR_2.1_b and b$VAR_2.1_a (continued below)

Test statistic	df	P value	Alternative hypothesis
-4.827	50	1.347e-05 * * *	two.sided

mean of the differences
-1.12

VAR_2.2

```
pander(t.test(paired = T, b$VAR_2.2_b, b$VAR_2.2_a))
```

Table 26: Paired t-test: b$VAR_2.2_b and b$VAR_2.2_a (continued below)

Test statistic	df	P value	Alternative hypothesis
-3.337	51	0.001587 * *	two.sided

mean of the differences
-0.7312

VAR_2.3

```
# Significant difference
pander(t.test(paired = T, b$VAR_2.3_b, b$VAR_2.3_a))
```

Table 28: Paired t-test: b$VAR_2.3_b and b$VAR_2.3_a (continued below)

Test statistic	df	P value	Alternative hypothesis
-4.269	51	8.544e-05 * * *	two.sided

mean of the differences
-1.083

VAR_3.1

```
# Significant difference
pander(t.test(paired = T, b$VAR_3.1_b, b$VAR_3.1_a))
```

Table 30: Paired t-test: b$VAR_3.1_b and b$VAR_3.1_a (continued below)

Test statistic	df	P value	Alternative hypothesis
2.043	51	0.04622 *	two.sided

mean of the differences
0.7462

VAR_3.2

```
pander(t.test(paired = T, b$VAR_3.2_b, b$VAR_3.2_a))
```

Table 32: Paired t-test: b$VAR_3.2_b and b$VAR_3.2_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
-1.944	51	0.05744	two.sided	-0.4885

VAR_3.3

```
pander(t.test(paired = T, b$VAR_3.3_b, b$VAR_3.3_a))
```

Table 33: Paired t-test: b$VAR_3.3_b and b$VAR_3.3_a (continued below)

Test statistic	df	P value	Alternative hypothesis
-2.934	51	0.005003 * *	two.sided

mean of the differences
-0.7046

VAR_4.1

```
pander(t.test(paired = T, b$VAR_4.1_b, b$VAR_4.1_a))
```

Table 35: Paired t-test: b$VAR_4.1_b and b$VAR_4.1_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
1.608	51	0.114	two.sided	0.485

VAR_4.2

```
# Significant difference
pander(t.test(paired = T, b$VAR_4.2_b, b$VAR_4.2_a))
```

Table 36: Paired t-test: b$VAR_4.2_b and b$VAR_4.2_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
-0.1262	51	0.9001	two.sided	-0.05115

VAR_5.1

```
pander(t.test(paired = T, b$VAR_5.1_b, b$VAR_5.1_a))
```

Table 37: Paired t-test: b$VAR_5.1_b and b$VAR_5.1_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
-1.098	51	0.2774	two.sided	-0.2612

VAR_5.2

```
pander(t.test(paired = T, b$VAR_5.2_b, b$VAR_5.2_a))
```

Table 38: Paired t-test: b$VAR_5.2_b and b$VAR_5.2_a (continued below)

Test statistic	df	P value	Alternative hypothesis
-2.449	51	0.01781 *	two.sided

mean of the differences
-0.5135

VAR_6.1

```
# Significant difference
pander(t.test(paired = T, b$VAR_6.1_b, b$VAR_6.1_a))
```

Table 40: Paired t-test: b$VAR_6.1_b and b$VAR_6.1_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
-2.159	51	0.0356 *	two.sided	-0.6131

VAR_6.2

```
# Significant difference
pander(t.test(paired = T, b$VAR_6.2_b, b$VAR_6.2_a))
```

Table 41: Paired t-test: b$VAR_6.2_b and b$VAR_6.2_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
0.6647	51	0.5093	two.sided	0.1885

VAR_7.1

```
pander(t.test(paired = T, b$VAR_7.1_b, b$VAR_7.1_a))
```

Table 42: Paired t-test: b$VAR_7.1_b and b$VAR_7.1_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
1.008	51	0.3183	two.sided	0.3523

VAR_7.2

```
# Significant difference
pander(t.test(paired = T, b$VAR_7.2_b, b$VAR_7.2_a))
```

Table 43: Paired t-test: b$VAR_7.2_b and b$VAR_7.2_a (continued below)

Test statistic	df	P value	Alternative hypothesis
2.101	51	0.04064 *	two.sided

mean of the differences
0.7

VAR_7.3

```
# Significant difference
pander(t.test(paired = T, b$VAR_7.3_b, b$VAR_7.3_a))
```

Table 45: Paired t-test: b$VAR_7.3_b and b$VAR_7.3_a

Test statistic	df	P value	Alternative hypothesis	mean of the differences
2.026	51	0.048 *	two.sided	0.5892

VAR_7.4

```
pander(t.test(paired = T, b$VAR_7.4_b, b$VAR_7.4_a))
```

Table 46: Paired t-test: b$VAR_7.4_b and b$VAR_7.4_a (continued below)

Test statistic	df	P value	Alternative hypothesis
2.581	51	0.01278 *	two.sided

mean of the differences
0.8908