Bitcoin: Users' characteristics, motivations and investment behaviours

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Abstract

In less than a decade, the cryptocurrency known as Bitcoin has gone from a fringe phenomenon to a topic of increasing interest to academia and mainstream investors. However, despite the growing body of research seeking to understand Bitcoin, the pseudonymous, decentralised, and globally-diffused nature of its user base means that the individuals who use it remain poorly understood. In particular, the motivations, risk-appreciation, and investment behaviours of early adopters and innovators are subject to supposition in the absence of data derived from the user base.

This thesis seeks to address this gap in knowledge by employing a multi-stage, mixed methodology approach and a theoretical framework to understand the Bitcoin user base. Utilising semantic analysis, a survey of online cryptocurrency communities, and econometric time-series analysis, this thesis addresses the extent and nature of Bitcoin in hedging; how individual users perceive their own motivations, uses, and risks that have driven their behaviour; and the nature of the relationship between the prices of cryptocurrency and indices of confidence.

Analysis of the data determined that the use of Bitcoin as an instrument of hedging is limited, and influenced by political and institutional factors. Likewise, its motivations, uses, and risks are reflective of the users' political ideology, with the community and marketplace becoming more sophisticated as they evolve over time. Additionally, despite several case studies demonstrating risk-averse adoption of Bitcoin, there is no relationship between its prices and confidence.

Statement of Authorship and Originality

Except where explicit reference is made in the text of the thesis, this thesis contains no material published elsewhere or extracted in whole or in part from a thesis by which I have qualified for or been awarded another degree or diploma. No other person's work has been relied upon or used without due acknowledgement in the main text and the list of references of the thesis. No editorial assistance has been received in the production of the thesis without due acknowledgement. Except where duly referred to, the thesis does not include material with copyright provisions or requiring copyright approval.

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Table of Contents

List of Figures

List of Tables

List of Appendices

1. Introduction

When research for this thesis began on March 30th 2015, the closing price of a single Bitcoin was USD$248.85. By December 16th 2017, the price of that same Bitcoin hit a record high of USD$19,343.04 before crashing to less than half that figure over the following months: just one example of the boom-and-bust cycles in prices that both preceded this episode and has continued ever since (CoinMarketCap, 2020).[1] This event, along with previous boom-bust periods, high-profile incidents of hacking, use of cryptocurrency in illicit activities, and increasing adoption for transactions, have all seen Bitcoin grow. This growth has proceeded from a fringe phenomenon embraced mostly by ideologically-motivated actors, nefarious operators, and the technologically savvy to an area of growing mainstream interest. Despite this, there are considerable gaps in the literature regarding the emergence and use of cryptocurrencies, particularly in regard to the user base, which is pseudonymous and globally diffuse.

This thesis will employ a multi-stage, mixed methodology to study Bitcoin with particular reference to the perceptions of its users. Given the growing public and media interest in Bitcoin, the aim of this thesis is to examine Bitcoin users as to the drivers that influence their adoption of such a non-state sanctioned currency both socially and economically. In outlining the aims and objectives of this thesis, there are three primary areas of focus that the research addresses: the nature of and extent to which Bitcoin is utilised as an instrument of hedging; the manner in which individual Bitcoin users perceive their own motivations, behaviours, and cryptocurrency usage; and the nature of the relationship between the price of cryptocurrency and indices of confidence. By examining these areas of focus this study aims to address the evolution of these concepts over time, using a specific conceptual framework derived from the extant scholarly literature on cryptocurrencies. This

[1] As of June 2019, the price of Bitcoin has surpassed $18,000 for the first time since 2017. However, by February 2020 the price had fallen below $9,000 (CoinMarketCap, 2020).

introductory chapter will consist of five parts, with section 1.1 detailing the basics of Bitcoin; section 1.2 presenting the research questions and objectives of this thesis; sections 1.3 and 1.4 outlining the contributions to the literature and the implications of the research, respectively; and section 1.5 will detailing the thesis structure.

1.1. Bitcoin Basics

Given that cryptocurrency is a relatively new phenomenon, both in the technological and economic sense, it is imperative to outline some of the basics prior to addressing the areas of the topic that this thesis seeks to address. In the simplest of terms, Bitcoin is an open-source digital currency and payment system which operates across a peer-to-peer (P2P) network (Brito and Castillo, 2013). Like all cryptocurrencies, of which it was the first and remains the largest, Bitcoin relies on the use of cryptography to verify transactions and facilitate the creation of new units of currency in the absence of a centralised ledger or minting agency (Chohan, 2017). The former function, the verification of transactions, is facilitated by the blockchain – a decentralised, public ledger which underpins the Bitcoin system – whereas the latter is provided by a process called mining, wherein new Bitcoins are produced and distributed in exchange for users contributing to the blockchain. Although this may sound rather complex, the process is deceptively simple. Anyone with internet access can create an account to use Bitcoin and receive a pair of cryptographic keys: a public-key, which is an alphanumeric code shared to the world that serves a similar function to an account address, and a private-key, which serves as a password known only to the user (Bitcoin Foundation, 2015). These serve to facilitate transactions between parties, with Brito and Castillo (2013, p. 5) succinctly describing the process thusly:

> When Alice decides to transfer Bitcoins to Bob, she creates a message, called a "transaction," which contains Bob's public key, and she "signs" it with her private key. By looking at Alice's public key, anyone can verify that the transaction was indeed signed with her private key, that is an authentic exchange, and that Bob is the new owner of the funds.

Whenever a transaction occurs, the transfer of funds between public-key addresses is recorded, time-stamped, and publicly displayed in a unit known as a "block." Due to the cryptographic algorithms underpinning the Bitcoin system, all devices in the network have a constantly updated and verifiable record of these transactions, ensuring that each individual Bitcoin is accounted for and cannot be fraudulently double-spent (Brito and Castillo, 2013).

The employment of a blockchain-based verification system addresses an issue prevalent in previous incarnations of digital currency known as the double-spending problem[2] – the ability to exploit flaws in the technological infrastructure to replicate and spend the same unit of money in multiple transactions (Chaum, 1992). As with any other transaction, the transfer of digital currency between actors who may have an incentive to engage in dishonest behaviour requires a means of ensuring that the conditions of the transaction are honoured by both the sending and receiving parties. Prior to the introduction of Bitcoin, the most common and dependable method of ensuring this was the presence of a trusted third party intermediary, with the means to reliably facilitate the transaction. Such services are typically provided by mainstream financial institutions such as banks, as well as a wide range of payment processors like PayPal. However, although fit for purpose in addressing concerns about the trustworthiness of parties to a transaction, the introduction of additional parties presents an economic inefficiency which innovators in digital finance have long sought to address. For instance, even assuming that these independent parties are in fact trustworthy, they require private information from the other parties to the transaction, are subject to legislative restraints and government interference in their operations, and charge additional fees in exchange for their services (Maurer, Nelms, and Swartz, 2013). This latter issue has been a particular driver in finding a means of facilitating digital transactions without the need for a third party. As noted by Maurer, et

[2] The double spending problem is a subset of an issue known more broadly in computer sciences as the Byzantine Generals' Problem, so named for an allegorical thought exercise involving the need to form a consensus amongst potentially dishonest actors (Lamport, Shostak, and Pease, 1982). While the latter term is commonly used in literature analysing Bitcoin from a technical perspective, the term "double-spending problem" will be employed throughout this thesis due to the socioeconomic focus of the research.

al. (2013, p. 265), Bitcoin has emerged as a repudiation of what some have termed as "flow capitalism," which involves "the profits extracted by those with a 'monopoly on transactions,' from the 'movement of values and not just their storage.'"

As previously noted, there is no independent third party that oversees this process when using Bitcoin, nor is there a centralised authority of any sort to verify transactions or mint new units of currency. Instead, the system is decentralised across a peer-to-peer network and subsequently relies on users contributing the computing power of their devices to oversee the process. Whenever a transaction occurs, the devices connected to the system solve a series of mathematical equations in order to check and verify the transfer of funds between parties, creating the aforementioned blocks that constitute the blockchain. This process of contributing to the blockchain is known as "mining," and in order to provide an incentive for individuals to maintain this system of decentralised infrastructure, new Bitcoins are produced and awarded to miners. The term "mining" derives its origins from the fact that Bitcoin was designed to serve as a virtual facsimile of gold and subsequently has a finite supply (Nakamoto, 2008). Only 21 million Bitcoins can be produced in total, and the number of new units of currency that enter circulation through this process halves each time 210,000 blocks are added to the blockchain. For instance, when the system first started out, the addition of new blocks to the blockchain resulted in the creation of 50 BTC[3], before falling to 25 BTC, then 12.5 BTC, and so on. This process will continue until the last 0.00000001 BTC is produced, which is projected to occur in 2140, at which point it is expected that Bitcoin will be valuable enough for transaction costs to provide enough of an incentive for continued mining (Brito and Castillo, 2013). Bitcoin can also be readily exchanged for fiat currencies, relying on a floating rather than fixed exchange rate that can fluctuate wildly on a day-to-day basis (Brito and Castillo, 2013).

[3] BTC is an acronym denoting Bitcoin in the same manner that AUD is used to refer to Australian dollars.

Since Bitcoin first came online, it has experienced exponential long-term growth, but with many short-term booms and busts. A single Bitcoin could be purchased for mere cents in its earliest days, they traded at over USD$1,000 for the first time in 2013 and almost reached USD$20,000 in 2017, although these periods were followed by price crashes (CoinMarketCap, 2020). Furthermore, the invention of the blockchain as a solution to the double-spending problem has spawned hundreds of competing cryptocurrencies that offer different functions or features in an attempt to improve upon the original Bitcoin model (Gandal and Halaburda, 2014). Although there are no barriers to entry in the market, and new cryptocurrencies are being constantly created, one of the defining features of a valuable medium of exchange is the willingness of others to accept it – a feature which Bitcoin, as the single largest cryptocurrency, continues to hold dominance over. This dominance can be attributed to its first mover advantage (Gandal and Halaburda, 2014). Indeed, for almost the entirety of its existence, the market capitalisation of Bitcoin exceeded that of all other cryptocurrencies combined, until the growth of its competitors caused it to lose that status in late 2017 (CoinMarketCap, 2020). For this reason, the cryptocurrency competitors to Bitcoin are most commonly referred as "altcoins," shorthand for "alternative coins" which denotes their continued second-tier status in the face of the original's market dominance (Bornholdt and Sneppen, 2014).

1.2. Research Objectives and Questions

As detailed in the introduction to this chapter, the thesis seeks to examine the motivations and behaviours of Bitcoin users in a social and economic context. Specifically, the research questions that are to be addressed are as follows:

> **Research Question (RQ) 1: What is the extent and nature of the use of Bitcoin in hedging, and how has this evolved over the period of its existence?**

Research Question (RQ) 2: How do individual Bitcoin users perceive their own motivations, uses, and risks that have driven their behaviour over the first decade of its evolution?

Research Question (RQ) 3: What is the nature of the relationship between the prices of cryptocurrencies and economy-wide indices of consumer and investor confidence?

A more in-depth examination of the research landscape and the gaps this thesis intends to address will be provided in the literature review in Chapter 2. However, prior to this, it is imperative to clarify some of the underlying terms and parameters in this analysis. Firstly, all research questions should not be interpreted as focusing on the Bitcoin user base in its entirety, but instead focusing on what this thesis has dubbed the "Bitcoin community." Although this concept will be elaborated upon in greater depth throughout this body of work, this term can be simply defined as that segment of users who regard themselves as part of a broader cryptocurrency movement and interact with one another on a social rather purely transactional level. Secondly, throughout this thesis, repeated reference will be made to "Bitcoin users" and the "Bitcoin user base," along with the "Bitcoin community." It should be noted that these terms will be employed interchangeably to describe the target group of this research, and they do not refer to the totality of all individuals who use Bitcoin except where otherwise stated. Thirdly, in answering these questions, the thesis will interpret its empirical findings through the application of the micro-meso-macro framework, which will be set out in Chapter 2.

Regarding the more specific terms employed in the questions, "hedging" refers to an investment that seeks to mitigate or completely offset a future risk. Attention should also be paid to the meaning of "economy-wide indices of consumer and investor confidence." Consumer confidence and investor confidence are indicators of the feelings of those respective groups regarding the state of the economy and the prospects for the future, measured on an index (OECD 2017a; 2017b). The

term “economy-wide” refers to the employment of US and OECD data to measure confidence, as these variables serve as a bellwether for trends on a global scale.

1.3. Contribution to the Literature

The recent emergence of Bitcoin has meant that academia has had little time to truly understand this phenomenon and construct new theoretical frameworks – a problem further exacerbated by the rapid growth of the cryptocurrency market and the delay in mainstream academics taking an interest in the subject. Socioeconomic research in particular is extremely scarce, while even the dominant fields of information-technology, economics, and law have only just begun to scratch the surface of the implications of cryptocurrencies (Morisse, 2015; Bonneau, Miller, Clark, Narayanan, and Felton, 2015). As such, this research project addresses a distinct gap in academic undertakings regarding the functionality and potential uses of Bitcoin and similar cryptocurrencies (Bonneau, et al., 2015). Whereas a growing body of literature is being produced which derives conclusions from quantitative data, in most cases this has thus far fallen short of translating into the construction of new theoretical perspectives (Morisse, 2015). By combining the user-derived data from this research with other works of academic literature and established theory, this project will seek to examine Bitcoin through the lens of the micro-meso-macro framework. Such an interpretation will provide a novel contribution to the literature, and establish a foundation for future analysis of cryptocurrencies.

A further contribution to the literature stems from the emphasis on user-generated data to address the research questions. While the publicly-accessible nature of the blockchain, along with other forms of market data, has yielded a wealth of economic data for analysis, the Bitcoin user base remains more opaque. A sizeable part of this problem can be attributed to the fact that it is difficult to actually communicate with individual Bitcoin users, and established economic theories can be of little use providing an explanation of their behaviour without direct engagement. However, such an

attitude is insufficient in understanding this new phenomenon, especially in light of the fact that studies that directly survey the Bitcoin user base have refuted a number of commonly-held assumptions in the past (Smyth, 2013). As such, the contributions of this thesis in addressing the problem of limited engagement with users are twofold. Firstly, the emphasis on deriving data directly from individual users ensures that the findings are not subject to many of the limitations found across the literature. Secondly, the construction of a multi-stage, mixed methods framework, as outlined in Chapter 3, allows this thesis to address many of the issues surrounding sampling the user base whilst simultaneously compensating for methodological shortcomings. This in turn represents a foundation contribution of the thesis, as this approach can readily be applied to future research on cryptocurrency.

1.4. Significance of the Research

Given the aforementioned paucity of information regarding cryptocurrencies in general, and the research topic in particular, the establishment of theoretical perspectives will provide a significant addition to the literature. Indeed, although the chosen areas of inquiry as expressed in the research questions are significant in their own right, an important contribution of this research will be the proposal of a theoretical and methodological framework for understanding Bitcoin. As elaborated upon in section 1.3, both the micro-meso-macro framework and a sequential analysis methodology to produce user-derived data are novel contributions to the analysis of Bitcoin. Given these contributions, the research not only addresses distinct and identifiable gaps in the literature, but also establishes a foundation that can be used to inform future research into cryptocurrencies.

Although the research is focused on providing empirical analysis and a theoretical framework, it also contributes to the understanding of the Bitcoin trading market. With the growing popularity of Bitcoin as a medium of exchange and an investment, mainstream financial institutions are examining the possibility of diversifying their holdings to include units of cryptocurrency (Woo, Gordon, and

Iaralov, 2013). However, much like governments, regulatory bodies, and academia, the private sector is being forced to grapple with the fact that there are still distinctive gaps in our understanding of cryptocurrencies and how they operate. This issue is further exacerbated by the volatility of cryptocurrency prices, meaning that any potential profits that could be derived from investment are accompanied by a correspondingly high risk of loss, as well as limited understanding of the motivations and behaviours of the user base. The focus on addressing these gaps provides a foundation for further analyses to build upon in regard to the role that Bitcoin can play within an investment portfolio. In particular, the examination of the relationship between economic confidence and its impact on cryptocurrency prices, as well as the risk appreciation of users, could inform investors in the identification of risk determinants.

1.5. Structure of the Thesis

This thesis consists of eight chapters, including this introduction, a literature review, a methodology, three empirical analysis chapters, a discussion, and a conclusion. Chapter 2 will be consist of a literature review addressing the research landscape, with particular emphasis on the theories underpinning this thesis and the gaps in knowledge the research questions seek to address. Chapter 3 presents the methodological underpinnings of this thesis, along with a justification for the forms of data collection and analysis employed. Chapters 4 through 6 present the research findings, with each dedicated to a particular methodological approach: a semantic analysis, a survey, and econometric analysis, respectively. The findings of these three chapters are tied together in Chapter 7, which addresses the research questions by way of an interpretative framework outlined at the end of the literature review. Finally, this thesis will conclude in Chapter 8, which will assess the contributions of the research, its implications, and present final remarks.

2. Literature Review

In 2008, Satoshi Nakamoto published his initial white paper outlining the technological foundations of a new digital currency model underpinned by cryptography. Since then, a large body of literature from a number of disciplines has emerged to provide academic insights into this new technological and economic phenomenon. The concept of a purely digital medium of exchange is by no means new to academia, with a number of economists, programmers, and political theorists all pondering the ramifications of the internet age upon the monetary system (Karlstrom, 2014). However, earlier attempts at bringing currencies into the digital realm were plagued by technological limitations, most notably the issue of "double spending" – the manner in which a single unit of currency can be fraudulently exchanged multiple times by the same person – and subsequent discourses were relegated to imagining the theoretical possibilities of the future. Nakamoto (2008) changed all that by solving the double-spending problem with the creation of the blockchain – a public ledger of transactions built upon cryptography and a peer-to-peer (P2P) system – transforming digital currencies from a futuristic fantasy to a practical reality. In the years since, Bitcoin has experienced a period of remarkable growth, and, while still quite small in comparison to the mainstream monetary economy, has received growing attention from academics across a number of disciplines (Brito and Castillo, 2013).

Academic literature on Bitcoin and other cryptocurrencies has predominantly emerged from within three major fields (Bonneau, et al., 2015; Morisse, 2015). Information technology, which is the largest field, concerns itself with the technological infrastructure underpinning cryptocurrency systems, its limitations, and how it can be improved. The next largest field is economics, which examines its viability as a currency, as well as its short- and long-term prospects. Then the legal and political sciences field addresses the unique challenges that decentralised, globally diffused, online

cryptocurrencies pose for legislators. This chapter critically examines some of the key findings and debates from within these three disciplines, as well as research put forth by the field of sociology, which, despite having put forward less research on the matter, has nevertheless infused an important social dimension into the discussion. The literature review consists of seven parts. Section 2.1 defines and explores the notion of a Bitcoin community and the motivations that drive it. Section 2.2 addresses the role of Bitcoin in the market and Section 2.3 expands upon this analysis with specific reference to hedging and speculation. Section 2.4 examines the literature on Bitcoin in an institutional and evolutionary context. Section 2.5 examines confidence in the use of Bitcoin by detailing case studies of risk-averse Bitcoin adoption. Section 2.6 presents the interpretative framework of this thesis. Finally, section 2.7 offers a brief summary.

2.1. The Bitcoin Community

As indicated in section 1.2, the research questions underpinning this thesis do not focus on the Bitcoin user base as a whole, but are instead oriented towards analysing the "Bitcoin community" as described in section 1.2. This section of the literature review examines the research surrounding this distinct subset of users.

2.1.1. Waves of Adoption in the Bitcoin Community

The research of this thesis is primarily focused on understanding the individuals that regard themselves as part of a "community" of Bitcoin users; who not only regard the cryptocurrency as a means to a particular economic end, but also feel personally connected to their fellow users and/or Bitcoin's potential to bring about disruptive changes. Given this specific focus, it is acknowledged that the research disproportionately reflects the views of some subgroups of users over others. For instance, speculators who regard Bitcoin solely as a source of short-term profit are less likely to be addressed by the data collection techniques employed in this thesis and, as such, the use of terms

like the “Bitcoin user base” is not intended to be inclusive of them. In making this point, it should be noted that this thesis focuses on speculation from the point of trading on price movements and manipulations, or what Irwin (1937) dubs “movement trading.” When viewed from a movement trading perspective, speculators based their investment decisions on exploitable opportunities as opposed to any relationship with the market. In the instance of Bitcoin, movement traders are attracted by its price volatility but would not establish themselves within a broader community. The research reflects the views of the earliest adopters of Bitcoin, as newcomers to the cryptocurrency market may either be influenced by the growing coverage of its profit-making potential or have yet to find a place within the aforementioned community. However, these two groups are not necessarily mutually exclusive.

Since the “Bitcoin community” comprises individuals who started using cryptocurrency in different waves of adoption, each of which possess their own unique motivations and mentalities, it is worth briefly touching upon the diffusions of innovation theory. Rogers (2003) argued that there are five waves of adoption in which individuals embrace a new form of innovation: innovators, early adopters[4], the early majority, the late majority, and what he termed as “laggards.” The innovators are those most willing to take risks on a new form of innovation, typically possessing the financial resources to both help the technology grow and absorb any losses along the way. These innovators are swiftly accompanied by the early adopters, who are forward-thinking enough to see the potential of an innovation and come to fill an opinion leadership role within a system. These individuals tend to attract the early majority, who adopt an innovation after these earlier groups, followed by the late majority, who tend to be more sceptical of innovations until it becomes more mainstream. Finally, there are the laggards, which as the name implies are the very last to embrace an innovation. In applying the five stages of adoption outlined by Rogers to Bitcoin, the

[4] Given that this thesis also makes the occasional reference to “early adopters,” it should be noted that later instances of this phrase are employed in the generic sense and are not intended to evoke the specific category of users as defined by Rogers.

cryptocurrency market can best be understood as being in the late stage of early adoption, with its increasing value and prominence in the media attracting a new wave of users but its price instability deterring mainstream actors (Tasca, Liu, and Hayes, 2018). As such, the "Bitcoin community" referred to within this research refers mostly to those defined by Rogers (2003) as the innovators and early adopters, although elements of the early majority will be present as well.[5]

2.1.2. Function of the Bitcoin Community

Given the focus on the Bitcoin community, both methodologically and theoretically, it is pertinent to also outline the function of this grouping for its constituent members. Given that the user base is decentralised and globally diffused, the Bitcoin community is often represented in online message boards and discussion forums, which will be the target of data collection and analysis in this thesis. These online groups are reminiscent of knowledge and innovation commons, part of the second generation of commons theories that expand upon the work of Ostrom (1990) by applying her observations on limited natural resources to intangible common pool assets such as culture, information, and innovation (Ostrom and Hess, 2007; Stern, 2011; Schweik and English, 2012).[6] As the name implies, a knowledge commons "refers to an institutional approach (commons) to governing the production, use, management, and/or preservation of a particular type of resource (knowledge)" (Madison, Frischmann, and Strandburg, 2019, p. 76). Such commons are well-represented in online spaces, where individuals gather within a decentralised context to pool and share information, and create institutions to curate it.

[5] The diffusions of innovation process and the limited stages that Bitcoin has undergone is reminiscent of its meso trajectory, as detailed in Section 2.6.

[6] The technological underpinnings of cryptocurrency, which are based on open source code and a P2P network, are also reminiscent of knowledge and innovation commons, as described by Schweik (2014).

The notion of an innovation commons, as proposed by Allen and Potts (2016), takes this concept further by arguing that the information shared within a knowledge commons in turn creates an environment in which new ideas are created. In proposing the concept of an innovation commons, Allen and Potts (2016) note that the emergence of new technology brings people together in a decentralised context to discover opportunities for its use and further development. This innovation commons is distinct as the common pool resource is not the technology itself, but rather the information and knowledge about it that can be used to reduce uncertainty and foster development. Potts (2018) reiterates that innovations commons are an efficient means of addressing the distribution of information and the uncertainty inherent in the earliest stages of innovation. Given the introductory nature of Section 2.1, and the fact that the motivations and behaviour of the Bitcoin community are going to be explored throughout this thesis, it is premature to provide specific examples of this in action. However, the concept of an innovation commons is a viable explanatory framework for understanding the Bitcoin community: as a means through which information and knowledge is shared, entrepreneurs derive ideas, and uncertainty is reduced.

While conceptualising the Bitcoin community as an innovation commons demonstrates its function for constituent members, it also demonstrates the risk of becoming what Earl and Potts (2004) describe as a "market for preferences." Earl and Potts likewise address the manner in which knowledge and information is transmitted between economic actors through social institutions, arguing that specialisation, the division of knowledge, and an overabundance of choice in the market creates a demand for perceived experts. However, they make a distinction between high-level and low-level preferences: the former being innate and dictating what an individual wants, the latter being more specific and pertaining to how these wants can best be achieved. This distinction is important in determining how individuals make decisions, with Earl and Potts (2004) arguing that while agents are sovereign when it comes to their high-level preferences, it may be more efficient to orient their low-level preferences around the opinions of perceived experts. This demand for the

preferences of experts arises in complex environments where the ability to acquire information is too time- or resource- consuming. Cryptocurrency fits such a definition, as it is a nascent marketplace underpinned by relatively new technology and constantly evolving. In this context, the Bitcoin community is not (or at least not exclusively) a commons where knowledge and innovations can be gathered, created, and distributed, but a mechanism through which preferences are disseminated. For example, an online message board may include threads in which those looking to invest in Bitcoin outsource their search for information to a handful of community experts, who in turn present the original poster with their own low-level preferences.

2.2. The Role of Bitcoin in the Market

Although RQ1 explores the role of Bitcoin as a hedge, this specific focus should not be misunderstood as an attempt to define it purely as such. Rather, it is an examination of one of numerous functions that Bitcoin plays within the market. Moreover, the other research questions contain broader focuses that necessitate an understanding of the other aspects of cryptocurrency. As such, before examining the literature specifically related to hedging, this section will examine the other roles of Bitcoin within the market, with a more specific institutional focus provided in section 2.4.

2.2.1. The Difficulty of Defining Bitcoin

Any discussion of the role of Bitcoin in the market cannot be addressed without first acknowledging the wider debate regarding how cryptocurrencies can best be defined. One of the more common debates consists of whether Bitcoin can best be classified as “commodity” or “currency/money”, given that its price volatility prevents it from maintaining a consistent store of value function and it defies many theoretical norms (Luther and White, 2014). Indeed, after examining Bitcoin from three different theories of money, Bjerg (2016, p. 53) quipped that “Bitcoin is commodity money without

gold, fiat money without a state, and credit money without debt", before adding that it "poses an ideological challenge to conventional forms of money… as it… provokes sedimented beliefs about money." Another debate, more relevant to this analysis, centres on whether or not Bitcoin is better understood as a commodity rather than as a form of currency (Glaser, Zimmerman, Haferkorn, Weber, and Siering, 2014). This relates to the fact that, while Bitcoin is capable of serving as a medium of exchange, much of its use comes from investors speculating on its future value or employing it as a hedge against inflation. This debate is further complicated by the fact that the manner in which Bitcoin is defined, at least in legislative rather than strictly theoretical terms, has broader implications on matters such as taxation. For instance, the conceptualisation of Bitcoin as a commodity was codified when the United States' Internal Revenue Service (2014) issued a ruling that cryptocurrencies were to be treated as property rather than currency for the purpose of taxation. This was soon followed by a similar ruling by the Australian Taxation Office (ATO, 2014), which states that "The ATO's view is that Bitcoin is neither money nor a foreign currency, and the supply of Bitcoin is not a financial supply for goods and services tax (GST) purposes. Bitcoin is, however, an asset for capital gains tax (CGT) purposes." While these rulings are sufficient to provide clarity to users regarding their tax obligations, this has done nothing to settle the broader debate within academia. Part of this problem is attributable to the fact that, to borrow an admittedly colloquial phrase, Bitcoin is 'neither fish nor fowl', exhibiting the traits of both currencies and commodities without rigidly adhering to either definition (Dyhrberg, 2015). Attempts to reconcile these differences through a broader focus on the blockchain will be outlined in Section 2.4.

2.2.2. Bitcoin as a Concurrent Currency

The emergence of a privately issued alternative to fiat currencies is reminiscent of arguments put forth by Austrian School economist F.A. Hayek (Rogojanu and Badea, 2014). Hayek (1990) theorised a system under which concurrent currencies would compete for market share in the absence of a

state monopoly. In building his conceptualisation of the "denationalisation" of currency, Hayek (1990) noted that even well-meaning governments and central banks could mismanage their monetary policy with disastrous results, whilst leaving the public with little choice but to continue to conduct transactions with a devaluing legal tender; a problem further exacerbated if the government institutes capital and currency controls that make it more difficult for its citizens to shift into alternatives, such as foreign currencies or commodities. To counter this issue, Hayek proposed that nation-states remove any legal obstacles preventing the trade of one another's currencies, or the issuance of private money, within their jurisdictions, thereby removing geographical monopolies on currency and creating competition. Although this theoretical framework infers possible benefits of cryptocurrencies divorced from central governments and states, Hayek did not live to experience the emergence of cryptocurrencies. Similarly, the technological, political, and economic limitations existing at the time of Hayek (1990) would ensure that his theory never entered into practice outside of failed states or local economies, with the theory subsequently falling into obscurity (Rogojanu and Badea, 2014).

Since the emergence of Bitcoin, Hayek's theory of concurrent currencies has seen a revival at the hands of contemporary scholars seeking to reapply it in the light of new technological possibilities. One of the most notable examples comes from Rogojanu and Badea (2014), who note that the globalised and decentralised nature of cryptocurrency has served to remove the barriers to concurrent currencies present in Hayek's time. Although their research is confined to analysing how the practical reality of Bitcoin compares to the theoretical possibilities envisioned by Hayek, Rogojanu and Badea (2014) nevertheless highlight the benefits and limitations of having a currency alternative. In particular, they note that allowing individual economic actors to access Bitcoin allows them to circumvent the problems of fiat currencies, such as warding against inflation, eliminating the need to trust in the competency of an overseeing agency like a central bank, and facilitating faster online transactions. However, they also note that competition cuts both ways and Bitcoin

possesses disadvantages not faced by fiat currencies, including its susceptibility to hacking, higher instances of fraud, and its ability to more easily facilitate illicit activities (Rogojanu and Badea, 2014). The notion of Bitcoin addressing some of the inherent flaws in fiat currencies, and vice versa, is reminiscent of the competitive aspect of Hayek's (1990) theory, that argues for multiple currencies competing in the same space rather than any one currency developing monopolistic dominance. At this point, it should be noted that cryptocurrencies are far too small to challenge fiat currencies for dominance of the market (Beer and Weber, 2014). However, the ultimate goal of Hayek's (1990) proposal is to introduce the benefits of free-market competition to the monetary system by allowing the provision of alternatives to poorly managed currencies, a notion to be discussed at length later in this thesis.

While the analysis by Rogojanu and Badea (2014) serves to relate Hayek's theory of concurrent currencies to Bitcoin, they neglect to note the limitations of his established theoretical framework. Most notably, Hayek passed away in 1992, meaning that he did not foresee the technological advances that would give rise to cryptocurrency, particularly on a globalised scale. As such, his conceptualisation of concurrent currencies is inherently limited by the notion of geographical boundaries, with Hayek (1990) believing that particular currencies would be favoured by nation-states or groups within them and that competition would be most prevalent on their overlapping borders. Bitcoin, however, avoids this issue as a result of its entirely digital nature, leaving it unconstrained in scope by the limits of geography and capable of being accessed by individuals in multiple economic jurisdictions. Furthermore, Hayek (1990) notes that such competition would serve as a precursor to the adoption of "honest money" – Austrian parlance for currency backed by a gold standard – and did not envision a digital currency that also partly derives its value from a limited supply. Nevertheless, the core of Hayek's (1990) argument – that a currency alternative provides individuals with a safeguard in the event of government or central bank mismanagement – is readily applicable to cryptocurrencies. As Beer and Weber (2014, p. 53, emphasis in original)

remark, “while Bitcoin does not rival the established monetary and payment systems in their traditional domains, *a complementary function is conceivable in niches.*” This notion, and the manner in which it relates to hedging, is expanded upon in case studies in section 2.5.

2.2.3. Bitcoin as a Trust-less Transfer Technology

In conceptualising Bitcoin as a concurrent currency – one that offers a private alternative to a government monopoly – the issue of trust in institutions becomes prevalent. Indeed, the European Central Bank (2012, p. 6) reports the emergence of cryptocurrency may “have a negative impact on the reputation of central banks… since the public may perceive [poor economic conditions] as being caused, in part, by a central bank not doing its job properly.” Blundell-Wignall (2014) argues further that Bitcoin’s ability to facilitate ‘trust-less’ transactions without the need for a third party constitutes the main innovation of cryptocurrency. However, the notion of declining trust in institutions should not be confined exclusively to the public sector or even Bitcoin’s function as a currency. For Novak, Potts, and Davidson (2018), there is ‘cost of trust’ in the most literal sense of the term, with their analysis estimating that 35% of the labour force in the United States in 2010 was employed in a profession responsible for maintaining trust between parties. While the blockchain will be addressed in-depth in section 2.4, it is worth noting its role in eliminating the need for a third party via the decentralisation of ledgers. As MacDonald, Allen, and Potts (2016) observe, emergent systems tend to begin with centralisation, as this is the most efficient structure for the establishment of new norms and rules. However, as the system becomes more established, decentralisation occurs as a response to issues of exploitation and rent-seeking. MacDonald, et al. (2016) argue that the cost of centralisation increases over time commensurate with such exploitation, while the cost of decentralisation concurrently decreases due to factors such as innovation and technological advancement.

Whereas the decentralisation of the issuance of currency primarily affects state institutions, the blockchain-based transfer system predominantly impacts private firms such as third-party payment providers and banks. MacDonald, et al. (2016) argue that banks themselves constitute an inefficient structure for economic organisation, but nevertheless persist because they address even greater inefficiencies inherent within the market due to the need for an independent third party to facilitate transactions. Although these institutions address the issue of trust, they also introduce an additional party to otherwise simple transactions, producing additional costs, centralising sensitive information, and raising the potential for interference. In discussing how Bitcoin was purposefully designed to address these issues, Maurer, et al. (2013) argue that cryptocurrency was designed to eliminate such middlemen and serves as a repudiation of what they dub "flow capitalism", or the system of taking a cut of every transaction in exchange for moving wealth rather than creating it. Maurer, et al. (2013) argue that the blockchain and the manner in which new units of currency are produced in exchange for verifying transactions ensures that capital is generated by miners as opposed to these middlemen.

Another issue raised by Maurer, et al. (2013) regarding the inefficiencies brought about by third party institutions is their ability to interfere in transactions despite their notional independence, whether as a result of their own terms of service or legal pressures, and the implications this raises regarding privacy. The level of personal information held by financial service providers possesses inherent value that can be exploited, with Maurer, et al. (2013, p. 265) noting that "many fear… that payment intermediaries have turned their users into labourers by transforming their activity into data." In this way, Bitcoin serves to "not only keep the 'middlemen' from profiting from transaction fees, but also from 'invading' transactors' privacy (or allowing government entities to do the same)". The ability of third parties to monitor transactions in this manner also raises the prospect for them to intervene in such activities or be pressured to do so, not merely in the justifiable instance of illicit activity but also in matters deemed to be objectionable. Indeed, Kreimer (2006) notes the position of

intermediaries in the online market allows them to serve as proxy censors, succumbing to pressure from state and/or private actors to deny service to those using their platform for controversial activities. A prominent example of this issue, as it relates to Bitcoin, is the online document-publishing platform WikiLeaks, which began accepting cryptocurrency to help fund its operations after PayPal and other intermediaries were pressured to freeze payments to accounts accepting donations on its behalf (Maurer, et al., 2013).

Even if the issues regarding data collection, commodification, and censorship were to be set aside, the ability of third parties to intervene in transactions in which they were only designed to serve as intermediaries creates inefficiencies that produce demand for an alternative. Indeed, even interventions specifically designed to benefit customers have produced unintended consequences across a number of third party payment systems. For instance, PayPal has received criticism from customers due to the high level of false positives generated by its fraud detection software – an issue further compounded by the perception of a harsh and/or inconsistent enforcement of its policies (Maurer, et al., 2013). However, Bitcoin is not necessarily a panacea to concerns regarding the oversight of, and intervention in, transactions between willing parties, even if the blockchain divorces the process from the need for an intermediary. After all, although Bitcoin has eliminated the need for various institutions, it has had to create new ones in their place, such as exchanges, wallet providers, and other service providers. Exchanges in particular have been the target of and demonstrated a willingness to comply with legislation, most notably in the instance of “Know Your Customer” and “Anti-Money Laundering” laws, commonly referred to as KYC/AML. These notions will be address at length in later chapters.

2.3. Bitcoin and Hedging

Bitcoin fills a number of roles in the market. However, this thesis, particularly via RQ1, focuses specifically on its hedging functions. Given this more specific focus, this section will examine the economic literature surrounding hedging and its role in investment.

2.3.1. Theories of Hedging

A hedge is a type of investment entered into to offset any potential losses in the future (Holthausen, 1979; Henderson and Hobson, 2002; Becherer, 2003; Smith and Stulz, 2005). In essence, a hedge can thus be regarded as a form of insurance for investors, providing them with a degree of protection in the event that economic conditions change in an undesirable manner. For instance, gold has a long history of serving as a hedge against inflation, as its store of value function causes its price to rise in nominal terms against a devaluing currency (Dempster and Artigas, 2010). While this particular example is pertinent, given that Bitcoin was designed to function as a virtual facsimile of gold, hedging can take a number of different forms via various instruments depending on the risks an investor is trying to offset. One of the more common hedging instruments is derivatives, such as futures, forwards, swaps, and options, which Saxena and Villar (2008, p. 72) define as "financial contracts that commit counterparties to exchange cash payments related to the value of a commodity or financial asset (underlying asset) with no actual delivery of the underlying asset." However, cryptocurrencies do not fall under such a definition, thus this analysis will focus on more comparable hedging instruments such as gold (Brito and Castillo, 2013), leaving the discussion of Bitcoin and hedging for section 2.3.3.

Although the definition of hedging and the basics of the practice are well-understood by academia, the exact role this investment plays in the economy is subject to broader debate. Classical and neoclassical schools of thought, for instance, tend to regard the economy as a self-regulating system

constantly seeking to maintain equilibrium (Anderson and Danthine, 1980). As such, risk aversive investments such as hedging serve to maintain this market equilibrium by providing a degree of protection against changing economic circumstances (Anderson and Danthine, 1980). In an analysis of the relationship between hedging, investment, and financing, Lin, Phillips, and Smith (2008) determine that the manner in which firms hedge is dependent upon their growth opportunities. Noting that previous analyses tended to examine only two of the three aforementioned factors, thus producing contradictory results, Lin, et al. (2008) develop a three equation system more consistent with the notion that these activities are all engaged in at the same time. Upon analysis of the results, Lin, et al. (2008) determine that firms with large growth opportunities engage in hedging to mitigate the risks associated with such growth, but do not do so to increase their leverage. By contrast, firms with fewer growth opportunities hedge in order to increase their leverage, thus mitigating some of the problems associated with underinvestment and providing a source of added value (Lin, et al., 2008). While all kinds of individuals and groups engage in hedging, the manner in which they do so is subsequently dependent upon the most threatening risks. An analysis of the manner in which Bitcoin may function as a hedging instrument must address both the kinds of economic losses that it can afford protection against, as well as identifying the particular demographic that finds such hedging most appealing.

2.3.2. Post-Keynesian Perspectives

A more critical perspective on hedging has been outlined in post-Keynesian literature. These critics argue that, although the classical and neoclassical schools allow for the impact of quantifiable risk on economic activity, they do not place significant emphasis on the impact of uncertainty and confidence on investments (Baddeley, 2007). This school of thought is an expansion upon the initial foundation established by Keynes (1938), who maintained that the free market requires institutions to maintain stability and address problems that cannot be solved through self-governance. In particular, Keynes advocated for central banks to control the money supply, maintain a steady rate

of inflation, and set interest rates; by contrast, these factors are left to the market in the case of Bitcoin and its institutions are diffused rather than centralised.

From the post-Keynesian position, the financial instability hypothesis pioneered by Minsky focuses on three main forms of investment: hedging, speculation, and Ponzi financing. Hedge financing units are capable of meeting all of their payment obligations out of their cash flows. Speculative financing units are capable of meeting their obligations but not repaying the principal. Ponzi financing units do not possess sufficient cash flows to repay either the principal or the interest, and can only sustain themselves through the sale of assets or further borrowing. Minsky (1992) argues that when hedge financing is dominant, the economy remains an equilibrium-seeking and containing system in accordance with classical theory. However, the greater the weight of speculative or Ponzi finance, the more likely that the economy becomes a deviation amplifying system, in which inflation and debt-deflation continue to grow. As such, the financial instability hypothesis is built upon two theorems: that the economy has financing regimes which are stable or unstable, and that over periods of prolonged stability, the economy transitions from these stable conditions to those that are unstable as periods of boom-and-bust increase in intensity (Minsky, 1992). Minsky (1992) concludes by noting that the financial instability hypothesis presents a model of the capitalist economy which does not rely on exogenous shocks to generate the business cycle, with periods of booms and busts compounded by the internal dynamics of the capitalist economy and the system of state interventions (especially central banks) designed to keep it operating within acceptable boundaries.

A core component of the financial instability hypothesis is the notion that the increasing pursuit of profits gradually sees the dominant financing model transitions from hedging to speculative to Ponzi, and from there to financial collapse (Minsky, 1992). This transition occurs because the optimism brought about by prosperity within a market system provides an incentive for both borrowers and

lenders to become more reckless in their decision-making. Under this scenario, the rising level of consequent defaults has a domino effect throughout the economy, resulting in even the holders of relatively safe hedging finances experiencing constraints on their ability to meet payments (Baddeley, 2007). In addressing the instability theory of Minsky (1986), attention should also be given to his work on the five stages of a bubble: displacement, boom, euphoria, profit-taking, and panic. The first stage occurs as investors rush to embrace a new technology, with the increased attention resulting in a transition to the boom stage. This boom in turn gives way to euphoria, as the profits generated during this upswing result in not only a loss of caution but also individuals who are less likely to engage with risky markets following the herd without the benefit of expert knowledge. Next, a profit-making stage eventuates where those with more knowledge or investment acumen recognise the signs of a bubble and sell their holdings to those joining the rush into the market. Finally, there is a panic driven by the recognition of an overvaluation and the market readjusts accordingly, results in a bust cycle (Minsky, 1986).

Post-Keynesian theory presents the business cycle as a product of the natural forces of the market, and argues that these excesses can be corrected by institutional governance. As noted by Baddeley (2007, p. 218), "the policy implication [of the instability brought about by this natural progression] is that capitalist economies should be supported by robust institutions (for example, strong central banks)", which is consistent with the orthodoxies of Keynesian and post-Keynesian economic theory. Goodhart (1989) argues that financial instability is best addressed by central banks through the implementation of monetary policy, particularly through changes to the money supply and interest rates. This implication is noteworthy in analysing the hedging potential of Bitcoin, given that the cryptocurrency model was deliberately designed to operate in the absence of any authoritative institution, including a central bank (Meiklejohn, Pomarole, Jordan, Levchenko, McCoy, Voelker, and Savage, 2013). As a result, it is possible that the cryptocurrency market could witness a similar transition from hedging to speculative to Ponzi financing if it experiences increasing rates of

adoption. Although the primary focus of this research is on conceptualising Bitcoin as a hedge, the work of Minsky demonstrates that this practice is inseparable from acts of speculation, which will feature into the analysis throughout this thesis.

2.3.3. Bitcoin and Hedging

One of the earliest examinations of Bitcoin as an instrument of hedging comes from Briere, Oosterlinck, and Szafarz (2015), who use weekly data from 2010 to 2013 to analyse the cryptocurrency from the perspective of a US investor with a diversified portfolio including both traditional and alternative assets. They determine that Bitcoin benefits from a low correlation with other assets, with only gold and inflation-linked bonds exhibiting a statistically significant correlation with the cryptocurrency at 17% and 16% respectively, resulting in diversification benefits to investor portfolios (Briere, et al., 2015). To ascertain the extent of these benefits, Briere, et al. (2015) add Bitcoin to three different types of portfolios: those consisting of traditional assets such as currencies, stocks, and bonds; those containing alternative assets, such as commodities, real estate, and hedge funds; and portfolios combining these two asset types. They find that Bitcoin significantly spans across all asset categories, with the results showing that portfolios which include cryptocurrency deliver better mean-variance trade-offs than those without. While acknowledging that Bitcoin investments carry a high level of risk along with their high returns, Briere, et al. (2015) argue that that this risk is compensated for by the low correlation with other assets, resulting in greater diversification benefits. Concluding that Bitcoin has considerable theoretical potential as a hedge for risk aversive investors, Briere, et al. (2015, p. 365) claim that even the inclusion of a small proportion of Bitcoins, at around 3% of an investor's portfolio, can "dramatically improve the risk-return trade-off of well-diversified portfolios".

A contrary perspective comes from Chowdhury (2016), who expands on the initial 2013 working paper of Briere, et al. (2015), by extending the sample period into 2014 and addressing some of the

methodological shortcomings in their analysis. Noting that the previous research relies upon mean-variance (MV) testing, which is underpinned by two major assumptions that are not expected to hold, Chowdhury (2016) extends the in-sample setting by also including an out-of-sample setting for analysis. After testing a number of the different values, the in-sample analysis yields different results than the study by Briere, et al. (2015). This appears to be a result of the longer sample period, as Chowdhury (2016) notes that the non-MV results support the suggestion of Briere, et al. that the addition of Bitcoin to a portfolio improves its performance. These findings contradict the out-of-sample scenario included by Chowdhury to improve on the original work of Briere, et al. (2015). Chowdhury (2016) finds that in an out-of-sample setting, portfolios that include Bitcoin induce more portfolio turnover compared with those that include only traditional asset classes,[7] and that the diversification benefits found in the in-sample setting are not preserved in any significant way under the new scenario. Chowdhury (2016) concludes by noting that his findings challenge the growing belief that the inclusion of Bitcoin within a portfolio results in better performance. This observation is particularly noteworthy, given that the analysis by Briere, et al. (2015) only adopted an in-sample setting, the very limitation that the Chowdhury's (2016) research sought to address.

Although the findings by Chowdhury (2016) may be indicative of methodological shortcomings on the part of Briere, et al. (2015), a more nuanced argument by Dyhrberg (2015) employs generalised autoregressive conditional heteroscedasticity (GARCH) volatility analysis to determine Bitcoin's hedging capabilities in comparison to gold and the dollar. Utilising Bitcoin price data from the July 2010 to May 2015, Dyhrberg (2015, p. 6) finds that the return on Bitcoins is "more affected by the demand for Bitcoin as a medium of exchange and less by temporary shocks to the price which

[7] As per Chowdhury (2016), traditional asset classes consist of investments such as stocks, bonds, currencies, commodities, and real estate. It should be noted that despite Chowdhury basing his research on that of Briere, et al. (2015), the latter had different definitions of traditional assets (worldwide stocks, bonds, hard currencies) and what they termed alternative investments (commodities, hedge funds, and real estate).

indicate similarities to currency". [8] This price data is also compared to a number of variables, including a number of gold prices, the dollar-euro and dollar-pound exchange rates, and the Financial Times Stock Exchange Index (FTSE Index). Upon examining the influence of these variables on Bitcoin prices, Dyhrberg (2015) establishes that cryptocurrency behaves similarly to traditional currency, with a significant reaction to the federal funds rate, but also exhibits other parallels to gold, including a reaction to similar variables in the GARCH model, its possession of hedging capabilities, and a symmetrical reaction to good or bad news on the market. Given these results, Dyhrberg (2015, p. 10) argues that "Bitcoin's position on the market would be between gold and the dollar on a scale with one extreme being pure store of value benefits and the other being pure medium of exchange advantages." This notion is reminiscent of the debate alluded to in Section 2.2 regarding how Bitcoin can best be defined, particularly in regard to the fact that it exhibits characteristics of both currencies and commodities without adhering exactly to either definition. Indeed, Dyhrberg (2015) argues that cryptocurrencies can best be understood as existing between the two on a spectrum rather than being one or the other. This acknowledges the nuance of the new form of technology and serves as a refutation of the critique outlined by Chowdhury (2016), who compares the applicability of Bitcoin in hedging against more traditional investments; whereas Dyhrberg (2015) suggests that cryptocurrency offers a similar but different complementary function.

The contradictory findings discussed in the previous paragraphs are compounded by a growing body of literature that seeks to analyse the performance of Bitcoin using modern portfolio theory (MPT). Acknowledging that the risk and return characteristics of an asset are inseparable, MPT seeks to optimise the expected return of a portfolio within the parameters of an investor's risk appreciation

[8] As noted by Dyhrberg, Hammoudeh and Yuan (2008) found similar results in their analysis of gold, further reinforcing the similarities to gold. To quote Dyhrberg (2015, p. 7) "it seems that Bitcoin and gold have similarities when it comes to the volatility of the return and what type of shocks are most influential, though currency similarities were also identified."

by calculating asset price correlation or the Sharpe ratio of past performances (Markowitz, 1952; Francis and Kim, 2013).[9]

One study by Andrianto and Diputra (2018) takes traditional assets including foreign currencies, commodities, stocks, and exchange-traded funds, along with three cryptocurrencies – Bitcoin, Ripple, and Litecoin – and applies the MPT framework to construct an optimal portfolio. Their analysis showed that Bitcoin enjoys a low correlation with other assets and provides greater diversification to portfolios, with their optimal allocation being between 5% and 20% of the portfolio depending contingent on the investor's risk tolerance. Another study by Henriques and Sadorsky (2018) demonstrates the benefits of Bitcoin, comparing benchmark portfolios that include US equites, bonds, and real estate, and Europe, Australasia, Far East (EAFE) equities with either gold or Bitcoin as the only variables. Their GARCH models determine that the portfolio including Bitcoin is preferable to risk-averse investors, and that these findings remain robust even after factoring in higher transaction costs relative to gold. However, Henriques and Sadorsky (2018) warn that their findings may be impacted by the lack of longer-term data and the continued uncertainty about the future of the cryptocurrency market. These caveats are pertinent given the findings of Shahzad, Bouri, Roubaud, Kristoufek, and Lucey (2019), who attempt to determine whether Bitcoin exhibits "safe haven" characteristics in a portfolio. Their research, conducted across a sample period from July 2010 to February 2018, compares Bitcoin's performance to that of gold and the general commodity index. The performance of these portfolios is tested against the indices of a number of stock markets, including the United States, China, and a mixture of developed and developing economies. Shahzad, et al. (2019) determine that the safe haven characteristics of Bitcoin are weak overall, and vary across time periods and stock market indices. They attribute these findings to the cryptocurrency market and the stock market having different investor profiles, with Bitcoin users

[9] The Markowitz (1952) model will be outlined in greater detail in Section 2.3.5.

tending to be young and inexperienced as investors and mainstream financial institutions being reluctant to take a risk on cryptocurrency.

In an analysis of the asset characteristics of Bitcoin from 2011 to 2018, Smales (2019) finds that while Bitcoin is not significantly correlated with other assets, it possesses less liquidity, greater volatility, and is more expensive to transact with. Smales (2019) notes that the cryptocurrency market is maturing over time and may become more viable in the future, but argues that it does not provide significant benefits in its current state. However, this argument is contradicted by Symitsi and Chalvatzis (2019), whose study evaluates the performance of Bitcoin in portfolios including fiat currency, gold, oil, stocks, and a diversified mixture of these assets. Their research shows that not only are the returns of including Bitcoin reduced in portfolios that accommodate more investment instruments, but that its diversification benefits – produced by its low correlation with other assets – are diminished when the cryptocurrency market is not in the midst of a bubble. In other words, the investment benefits of Bitcoin may just be attributable to the high risk, high return nature of its boom-and-bust cycles, and would therefore diminish if the market ever becomes stable on a day-to-day basis. Such an argument is reinforced by Kajtazi and Moro (2019), who attribute the benefits they identify in adding Bitcoin to portfolios of US, European, and Chinese currencies to the increase in overall returns as opposed to any reduction of volatility.

These disparities in findings are representative of the assumptions underpinning each model, and the difficulties in acquiring accurate data to analyse Bitcoin. In particular, the relatively short lifespan of Bitcoin, combined with its price volatility over that period, limits the usefulness of using past data in making future projections (Henriques and Sadorsky, 2018). It should also be noted that the nascent Bitcoin market has undergone a number of significant changes over its existence, and that its ongoing evolution affects its investment potential. Citing research that is addressed in Section

2.4, Kajtazi and Moro (2019) note that Bitcoin has evolved along three distinct phases, and that its role within a portfolio in more recent years is fundamentally different to its infancy or when it was primarily used for sin enterprises (see also Tasca, et al., 2018). Symitsi and Chaltvatzis (2019) similarly note that the return benefits of Bitcoin differ between time periods, not simply due to random quirks of price volatility but to changes in the nature of its market. In applying these differing findings to the research, two trends become noticeable. Firstly, the inherent uncertainty about Bitcoin's future and the difficulty in creating effective models limits its potential as a hedge. Secondly, and perhaps conversely, one of the few consistent findings to emerge from the literature is that Bitcoin possesses a low correlation with other assets, and, despite overlaps, is largely unique. This suggests that Bitcoin has the potential to play novel or niche roles within an investment portfolio, once its benefits and limitations are properly understood.

Despite the varied conclusions derived from these studies, each offers a number of insights that are pertinent to this research. Firstly, the role of Bitcoin and similar cryptocurrencies in the practice of hedging is not yet adequately understood by the literature as it currently stands, presenting opportunities for additional research to examine this phenomenon. Secondly, even in light of these divergent arguments, the current literature shares a key methodological similarity: namely, the use of economic modelling to determine the theoretical practicality of Bitcoin as an instrument of hedging, as opposed to how it is currently being employed by its users in a real-world setting (Briere, et al., 2015; Chowdhury, 2016; Dyhrberg, 2015). This is indicative of a different research focus, as opposed to any deficiencies on the part of the established literature. After all, any discussion of the potential use of cryptocurrencies as a form of investment should be accompanied by a critical analysis of whether or not such activities are worthwhile. However, this singular focus is indicative of a gap in the literature which should be addressed. Expanding the scope of the analysis beyond examining how cryptocurrencies may impact upon a theoretical portfolio to incorporate how users

are actually utilising them has the potential to yield new insights into Bitcoin, particularly regarding whether or not it can adequately be described as a hedge.

2.3.4. Hedging and the Paradox of Risk

Although the literature demonstrates the theoretical possibility of Bitcoin serving as a hedge, it must nevertheless be acknowledged that the cryptocurrency market comes with a number of risks which undermine its investment potential. In particular, Bitcoin has been subject to a number of high-profile incidents of hacking, theft, and fraudulent business practices, while the entirely digital nature of cryptocurrency opens it up to risks that do not affect fiat currencies (Bohme, Christin, Edelman, and Moore, 2015). Indeed, a branch of literature from the discipline of information technology specialises in theorising methods of exploiting vulnerabilities in the technical infrastructure in order to hack the Bitcoin market (Eyal and Sirer, 2014). While a more detailed analysis of specific incidents is provided in the following chapters, it must nevertheless be acknowledged that these flaws have raised concerns about the long-term viability of cryptocurrency in general, to say nothing of its application as an instrument of hedging. In one of the more critical analyses of Bitcoin, Hanley (2015, p.3) argues that these hazards grant an "'Emperor's New Clothes' cast" to cryptocurrency, given that its flaws seem "overwhelmingly obvious, [despite] the publication record show[ing] otherwise." Even ignoring the risks brought about by the deliberate actions of immoral agents, the influence of natural market forces in the absence of a central authority also produces risks such as price volatility. Thus, Grant and Hogan (2015) note that while proponents of Bitcoin tend to focus on its benefits such as facilitating lower online transaction costs, the lack of a governing agency to limit these market forces merits careful consideration by those seeking to use cryptocurrency as a medium of exchange or investment asset. Malovic (2014, p. 32) takes this argument further by arguing that Bitcoin's volatility limits its ability to hold a store of value function, its susceptibility to theft and hacking in the absence of formal reserves or deposit insurance makes it a risky asset to hold, and its "next to none

correlation with other major currencies' movements renders it unsuitable for managing FX risk or hedging purposes." However, Malovic (2014) also acknowledges that the technical infrastructure underpinning Bitcoin may evolve to address these problems given the increasing role of information technology in the financial sector, a notion expanded upon further herein.

The notion of exploitative practices within the cryptocurrency market, and their broader implications on investment activity, are inseparable from the regulatory frameworks which seek to govern such behaviour. Imposing a regulatory framework on cryptocurrency is difficult due to its anonymous, globalised, and decentralised nature, which has resulted in varying degrees of state interference across different jurisdictions (Brito and Castillo, 2013). Indeed, although a growing body of literature has emerged within academia to discuss how cryptocurrency can fit into existing taxation, licensing, investment, consumer protection, and even counterfeiting laws; regulatory bodies have been much slower in implementing these recommendations (Kaplanov, 2012; Dion, 2013). Within an Australian legal context, Parsons (2016, p. 184) notes that "there is at present no comprehensive and clear legal protection for Australian consumers acquiring Bitcoins and/or transacting with Bitcoins for goods and services." Concordantly, although the ATO (2014) has released a statement outlining the tax obligations of Bitcoin users which clarifies that the regulatory agency regards cryptocurrency as an asset subject to the capital gains tax, state intervention has been lacking in other areas (Parsons, 2016). In part, this absence of regulation is attributable to the aforementioned difficulties in crafting legislation which is enforceable, a broader lack of understanding of this new technological and economic phenomenon, and the fact that the cryptocurrency market is so small that it presents minimal to no risk of causing disruptions in the mainstream economy (Kaplanov, 2012). Christopher (2014) notes that attempts in the United States to combat cybercrime in the cryptocurrency market by punishing financial institutions such as exchanges rather than the criminals themselves has only served to produce a "whack-a-mole" effect, whilst undermining more effective cooperation between law enforcement and the Bitcoin community. Additionally, these issues regarding the efficacy of

regulation are compounded by the risk that imposing a legislative framework on cryptocurrency without adequately understanding the needs of its user base risks limiting growth and investment in the emergent industry (Kaplanov, 2012). Indeed, even advocates of regulation such as De Filippi (2014) acknowledge that self-regulation may be a necessary solution to problems so as not to stifle innovation in the nascent marketplace.

2.3.5. Models of Hedging Behaviour

While the preceding subsections outlined some of the theories surrounding hedging, a mathematical model is necessary to explain why individuals engage in this form of investment.[10] A number of basic models are applicable to this analysis, including the Black-Scholes (1973), portfolio insurance (Rubinstein and Leland, 1995), and binomial options pricing (Cox, Ross, and Rubinstein, 1979) models. One of the simpler models used to examine hedging behaviour is the minimum variance portfolio (MVP) outlined by Bodie, Kane, and Marcus (2017), which calculates the allocation of assets in a portfolio based solely on measurements of risk, as opposed to the standard risk-return considerations encountered in Markowitz (1952) portfolio selection and other prevalent models. The MVP formula calculates how much should be invested in each asset being considered to construct a portfolio that minimises risk exposure as much as possible. Assuming a hypothetical two-asset portfolio where the two choices under consideration are Bitcoin and another asset class[11], the MVP formula can be expressed as follows:

[10] Due to the exploratory nature of this thesis, this section will present simplified hedging models which incorporate Bitcoin as part of a two-asset portfolio. While these models can be expanded to include multiple assets, the principles of hedging remain the same. For this reason, and because presenting a multi-asset portfolio case of hedging requires expanded mathematical derivations that are not the primary aim of this research, the thesis will employ these simplified models for the sake of clarity and concise presentation.

[11] Due to the simplified nature of this model, the asset in question can be a fiat currency, gold, a stock, or a bond without requiring alterations to the formula.

$$x = \frac{(\sigma_b{}^2 - \rho_{ab}\sigma_a\sigma_b)}{(\sigma_a{}^2 + \sigma_b{}^2 - 2\rho_{ab}\sigma_a\sigma_b)} - - - (Equation\ 2.1)$$

Under this formula, *x* is the percentage of the portfolio allocated into Bitcoin, σ_a is the standard deviation of Bitcoin, σ_b is the standard deviation of the other asset class, and p_{ab} is the correlation between the two assets. By calculating the value of *x,* it is therefore possible to determine the optimal percentage of Bitcoins to include in the portfolio to reduce risk to its lowest level, irrespective of the potential for profit.

Although the MVP model is useful for determining the optimal level of risk minimisation in a portfolio, it is not well-suited for factoring in the impact of change over time. This is an especially pertinent variable, particularly given the day-to-day volatility evident in Bitcoin prices (CoinMarketCap, 2020). However, given the objective of minimising risk, as under the hedging strategy, the proportion of Bitcoin in the portfolio needs to be dynamically rebalanced considering the day-to-day volatility of the market and the portfolio performance.

Another application of Bitcoin is in the dynamic hedging of a portfolio with the cryptocurrency considered as an asset class in the binomial option pricing model of Cox, et al. (1979). This model seeks to maintain the original value of a portfolio by adjusting the number of assets held over a given period. In the simplest of terms, a hypothetical portfolio that consisted of Bitcoins and a fiat currency could be expressed as follows:

$$\Delta B + C - - - (Equation\ 2.2)$$

In this simplified Equation 2.2, Δ denotes the number of Bitcoins held, *B* is indicative of Bitcoin's current value, and *C* is the value of the fiat currency held. Over a given period, it can be assumed that the value of Bitcoin will either go up (becoming *uB*) or down (becoming *dB*), while the value of

the fiat currency will be subject to the rate of inflation over that period (resulting in *rC*). This means that over time, the original equation will become one of the following:

$$\Delta uB + rC \text{ (with probability } q)$$
$$\Delta dB + rC \text{ (with probability } 1 - q) - - - (Equation\ 2.3)$$

Under binomial option pricing, the purpose of hedging is to ensure that the balance of the portfolio reverts to its original value after these changes have occurred. Or, as Cox et al. (1979) express it in mathematical terms, it should eventually be the case that:

$$\Delta B + C = \Delta uB + rC = \Delta dB + rC - - - (Equation\ 2.4)$$

Given that both the price of Bitcoin and the inflation rate are factors outside the control of individual investors, this is realised by altering the holdings of Δ or *C* in the portfolio to restore its original value. This is achieved by solving the equation for Δ like so:

$$\Delta = \frac{(uB - dB)}{B(u - d)} - - - (Equation\ 2.5)$$

This will determine the optimal holdings of Bitcoin within the portfolio to maintain its original value in light of changing prices and inflation.

Given the inherent volatility in Bitcoin's prices and its lack of a store of value function, along with the other risks outlined in subsection 2.3.4, the established models seem insufficient for explaining the use of Bitcoin in this capacity. After all, if the objective is to maintain the value of a portfolio over time, Bitcoin seems poorly suited to the role. Even if one only factors in the two assets used in the above examples, fiat currencies on the whole tend to be more stable than cryptocurrencies.[12] Factoring in additional investment options that may better be fit for purpose – gold, for instance –

[12] Exceptions to this will be outlined in Section 2.5. However, it must be acknowledged that these are representative of exceptional circumstances, and not the norm.

further compounds this issue. Therefore, there are additional variables at play that influence investor behaviour, at least insofar as they are engaged in hedging. The literature points to a number of theoretical possibilities: distrust of governments, central banks, and/or fiat currencies (Karlstrom, 2014); restrictions on capital allocation and access to other investment options (Ussing, Bak, Nelborn, and Bacher, 2014); and its technological accessibility (Clegg, 2014). However, these possibilities are difficult to factor into this study without more information at hand, especially given the exploratory nature of this research. Based on the empirical findings from this project, the discussion in Chapter 7 elucidates more on these possibilities than currently exists in the literature.

2.4. Institutions and Evolution of the Bitcoin Market

This section details the manner in which the market, and the institutions comprising it, have evolved over time. For the purposes of this thesis, it is useful to adhere to the definition of markets provided by Hodgson (1988, p. 174), who adopted the broad view that "a market is a set of social institutions in which a large number of commodity exchanges of a specific type regularly take place, and to some extent are facilitated and structured by these institutions."

2.4.1. The Emergence of Institutional Entrepreneurship

One of the earliest examinations of the Bitcoin community and the manner in which it has self-organised comes from Teigland, Yetis, and Larsson (2013). Their analysis employs a particularly innovative method for circumventing the inaccessibility of individual Bitcoin users in order to examine the emergence of institutional entrepreneurship, which Maguire, Hardy, and Lawrence (2004, p. 657) describe as the "activities of actors who have an interest in particular institutional arrangements and who leverage resources to create new institutions or to transform existing ones." In the simplest of terms, the theory of institutional entrepreneurship maintains that just as extant institutions order the behaviour of individuals or groups within a particular system, so too can these

actors change the institutions that govern them through reform or innovation (Garud, Jain, and Kumaraswamy; 2002; Greenwood, Suddaby, and Hinings, 2002).

Targeting the highly-trafficked website, Bitcointalk.org, Teigland, et al. (2013), utilises webscraper software to gather together all the posts on the forum and study them using semantic analysis. Through this approach, they compile a database of 1.15 million discussion posts written by 21,903 members, and analyse it to determine key conversation topics and trends. After compiling a list of each individual word used and their frequency, Teigland, et al. (2013) conduct a cluster and factor analysis, identifying eight relatively active topics of conversation. Of these, three topics of a technical nature relate to the installation and use of Bitcoin mining hardware and software, two topics focus on the trading of Bitcoins on exchanges, and three topics discuss ongoing legal issues. Teigland, et al. (2013) note that the earliest topics address on the operational issues of how to mine and use Bitcoin, while later topics begin to focus on perceived threats to the marketplace. By reading forum posts as well as other sources of discussion online, Teigland, et al. (2013) are able to determine the growing prominence of internal threats to the Bitcoin system, and also how individuals collectively self-organise in the absence of a central authority to counter them. In particular, they note the emergence of "institutional entrepreneurship" through the development of formal organisations such as the Bitcoin Foundation, to provide a legitimate face to the interests of the Bitcoin community, as well as informal organisations, including online watchdogs on the forum which monitor and record serious instances of fraud, theft, and hacking (Teigland, et al., 2013).

These findings are particularly noteworthy given that they derive from Bitcoin users in a "natural" setting, where comments were not influenced by the researcher-subject relationship that would be found in a direct-contact methodological approach (Shank, 2006). Nevertheless, it must be acknowledged that the study by Teigland, et al. (2013) is limited in scope, albeit due to their specific research focus as opposed to any underlying methodological flaws. In particular, Teigland, et al.

(2013) attempt to determine which subjects are the most frequently discussed, as opposed to identifying key topics of interest which could then be isolated in the raw data to determine how influential they are. Although this approach removes any possibility of skewing the results with bias on the part of the researchers, it also limits the number of statistically significant findings that could be derived with such a large sample pool. For example, although Teigland, et al. (2013) were able to identify the growing prominence of internal threats such as hacking, fraud, and theft, the fact that discussions on external threats such as mainstream institutions, economic conditions, and the threat of regulation fail to meet their threshold prevented the possibility of a comparative analysis between the two types of threats. However, the possibility of an increased scope for inquiry highlights the usefulness of semantic analysis as a methodological approach capable of circumventing the anonymity of the Bitcoin community whilst deriving a statistically significant sample of users.

2.4.2. The Evolution of the Bitcoin Market

The debate surrounding the practicality and long-term viability of self-regulation has a long pedigree in economics, irrespective of its relationship to Bitcoin (Hayek, 1978; Black, 2001; Reinhart and Rogoff, 2009; Mazzucato, 2018). However, a more recent analysis of the evolution of the Bitcoin market by Tasca, et al. (2018) demonstrates an increasing shift towards legitimate enterprises in the absence of state intervention. Collecting data on Bitcoin transactions between 2009 and 2015, Tasca, et al. (2018) identify particular business categories and analysed them to create a map of the network of relationships between them.

Upon analysis of the findings, Tasca, et al. (2018) identify three phases of development that Bitcoin has gone through since its inception. The first period runs from January 2009 to March 2012 and consists of a ‘proof-of-concept’ period, in which a small number of users engage in mining with

minimal commercial activity. The second period, from April 2012 to October 2013, sees the introduction of early adopters. However, Tasca, et al. (2018) note that this period is also characterised by an influx of 'sin' enterprises, including the use of Bitcoin in online gambling and black market transactions over the Darknet. The final period emerges from November 2013 onwards, when the inflows attributable to 'sin' enterprises shrinks to approximately 3% or less of all transactions and the number of legitimate payments and services increases (Tasca, et al., 2018). This evolution of the Bitcoin system from a proof-of-concept phase to a sin-based economy to an increasingly mature and legitimate market reflects a degree of collective self-organisation amongst users and businesses in the absence of a centralised authority, a notion reflective of Hayek's (1978) theory of spontaneous market order. More pertinent to this research, the findings of Tasca, et al. (2018) serve to repudiate a number of critiques regarding cryptocurrency, which may have been accurate at the time of their writing but are reflective of conditions during Bitcoin's earlier, less legitimate phases.

2.4.3. Institutional Cryptoeconomics and the Role of the Blockchain

In examining both the emergence of social institutions in the cryptocurrency market and exploring their evolution, it is useful to set Bitcoin aside and instead focus on the blockchain technology underpinning it. In particular, there are a number of insights that can be derived from the emergent field of institutional cryptoeconomics, which Berg, Davidson, and Potts (2018) describe as the study of decentralised ledgers and their institutional consequences. Potts (2011) notes that the blockchain serves as an open platform technology, providing a system of rules within a decentralised context. In outlining the basic economics of the blockchain, Gans and Catilini (2019) identify two primary cost reductions generated by the technology that help drive competition and innovation amongst digital platforms. Firstly, due to the blockchain functioning as a ledger maintaining a clear record of ownership, the cost of verification is reduced. Secondly, there is a reduction in what they term the

cost of networking, which relates to the ability to bootstrap[13] and run a marketplace in the absence of a centralised authority. Gans and Catilini (2019, p. 1) explain that this has institutional implications, as the "resulting digital marketplaces allow participants to make joint investments in shared infrastructure and digital public utilities without assigning market power to a platform operator, and are characterised by increased competition, lower barriers to entry, and a lower privacy risk." However, they also acknowledge that the nature of a decentralised system creates new inefficiencies and challenges to effective governance structures.

Davidson, De Filippi, and Potts (2016) argue that blockchain is representative of far more than just a technological innovation, as it allows both innovation-centred and governance-centred models to emerge for creating spontaneous organisations. Instead, it can be regarded as a spontaneous and self-governing economic system, which Davidson, et al. (2016, p. 2) claim combines "the coordination properties of a market… the governance properties of a commons… and the constitutional properties of a nation state." In a later analysis, Davidson, De Filippi, and Potts (2018) take this argument of a new self-organised economy further by identifying blockchain as an innovation technology distinct from an industrial technology; whereas the latter impact on efficiency through their adoption into firms, the former reduce the transaction costs of economic coordination and governance, resulting in the evolution of institutions. Such a framework makes the Schumpeterian (1994) notion of creative destruction poorly suited to the understanding of blockchains, as made explicit by Allen, Berg, Markey-Towler, Novak, and Potts (2019, p.4):

> Little attention has been given to institutional innovation in Schumpeterian models because institutions are traditionally slow to evolve… As an institutional technology, blockchain facilitates institutional entrepreneurship over new forms of economic coordination and governance. We can no

[13] The term "bootstrapping" refers to the ability to finance the start-up and growth of a firm (or in this context, a market) with limited resources, in the absence of support from mainstream institutional investors (Bhide, 1992; Jones and Jayawarna, 2010; Lam, 2010).

> longer abstract away from institutional evolution and still have a perspective on economic systems consistent with reality. Evolution of industrial technologies now takes place across multiple systems of institutional governance enabled by a diverse set of institutional technologies that evolve. This new class of technological change – the evolution of a technology of governance – requires new understanding of the dynamics of that change that are not represented well by standard replicator… or diffusion models.

Given that Allen, et al. (2019) explicitly identify conventional institutional theories as ill-suited to the understanding of blockchains, consideration should be given to the insights of institutional cryptoeconomics regarding Bitcoin. Allen, et al. (2019) present the micro-meso-macro framework as a useful perspective for understanding blockchains from an institutional and evolutionary perspective, which forms the basis of section 2.6. However, prior to that, attention should be given to the conceptualisation of Bitcoin as a catallaxy, which is in turn an outgrowth of the 'constellaxy' institutional technology proposed by MacDonald, et al. (2016).

2.4.4. Bitcoin as a Catallaxy

The notion of institutional cryptoeconomics is closely related to the conceptualisation of Bitcoin as a catallaxy, as proposed by MacDonald, et al. (2016). An alternative expression of the term "economics", catallactics seeks to understand markets through the context of the decentralised and uncoordinated actions of individuals giving rise to spontaneous order. The term itself was coined by Whately (1832, p. 4), who objected to what he perceived as a flaw in the etymological roots of the word "economy" – which is derived from the Greek term meaning 'household management' – and the biases it might engender. Instead, Whately (1832, p. 4) prefers the term "catallactics" or the "Science of Exchanges." In essence, Whately argues that the discipline of economics should concern itself with understanding market phenomena as they are in the real world, as opposed to how they

should be in the eyes of the economist; which can be realised by employing objective reasoning rather than value judgements. The natural inference of this approach is that the economy should not be understood in collective terms vis-à-vis institutions or society, but rather traced back to the point of individual actors making decisions in their own self-interests (Hayek, 1977). Whately's conceptualisation of catallactics was later embraced by the free market Austrian School of economics, featuring prominently in the writings of its leading scholars, including Ludwig von Mises and F.A. Hayek. Hayek in particular popularised catallaxy through his embrace of the term, due to his belief that the translation of 'economy' into its root of 'household management' implies that economic actors within a market possessed shared goals; a view which he categorically rejected. Rather, Hayek (1977) envisions catallaxies as decentralised systems, in which order emerges spontaneously as individuals engage in the market and adjust their behaviours in response to one another.

On the surface, the difference between a "catallaxy" and an "economy" may seem like a shallow one: a semantic quibble over the constituent components each term calls to mind, as opposed to a genuine definitional distinction (Machlup, 2003). Indeed, its etymological roots notwithstanding, the term 'economy' is often used as a catch-all term in contemporary parlance to describe markets of various iterations, and economists belonging to the free market schools of thought appreciate them within a theoretical framework that focuses upon the individual. However, in providing further definition to the concept of catallaxy, Hayek (1977) ties the conceptualisation of a catallaxy specifically to free markets underpinned by the decentralisation of control and the distribution of information processing. By contrast, in Hayek's (1977) view, an 'economy' is defined by an institution or system of governance which exerts influence over the market in pursuit of a uniform hierarchy of ends. Within this context, catallaxies are distinct from economies as both a type of market and a type of governance institution, with unique defining traits. These include a constitution or a set of foundational governing principles which underpin it; collective, rather than centralised, rules and

procedures for the making of decisions; and the dominance of decentralised markets rather than hierarchical organisations (Hayek, 1977).[14] Given this emphasis on underpinning rules of governance, it is important to clarify that this need not imply a formal state apparatus, although the two are not mutually exclusive. Insofar as formal, hierarchical institutions such as the state are involved in catallaxies, they serve only to provide protections for an agreed upon series of rights rather than intervening in the free exchanges of the market.

In applying the Austrian School conceptualisation of catallaxy to Bitcoin, MacDonald, et al. (2016) chose to focus not on the cryptocurrency itself, but rather the blockchain technology underpinning it. By its very nature, blockchain is a disruptive form of technology, serving to remove the need for middlemen in transactions that previously required a centralised third party authority. This phenomenon has already been addressed in regard to the research subject, cryptocurrency, with the blockchain supplanting governments and central banks in the issuance of new currency, as well as third party financial systems such as PayPal during online transactions (Brito and Castillo, 2013). However, it can just as readily be applied to any activity that previously required a centralised ledger, and has been employed in the execution of smart contracts, the storage of restricted-access digital records, the issuance of company shares, processing insurance claims, and even verifying the authenticity of rare artworks to protect against forgeries (Pilkington, 2015; Zhao, Fan, and Yan, 2016; Kakavand, Kost De Sevres, and Chilton, 2017). As such, blockchains serve as a means through which a multitude of individuals spontaneously move away from economies governed by hierarchical institutions and towards decentralised markets or catallaxies. Blockchain does not merely serve as a catallaxy itself, but rather provides a means through which catallaxies are themselves created across various sectors of the economy (MacDonald, et al., 2016). In this context, blockchain is a 'constellaxy'; a term previously defined by MacDonald (2015, p. 2) as "the order brought about by

[14] Hayek (1990) takes this argument even further in his theory of concurrent currencies, as outlined in Section 2.2.

the mutual adjustment of many individual participants in a social… network," an intentional paraphrasing of Hayek's (1977) original interpretation of catallaxy.

In identifying the catallactic nature of markets underpinned by blockchains, MacDonald, et al.(2016) point to a number of specific features blockchain technology possesses which impact upon formerly centralised economies. In particular, blockchains are not burdened by territorial or jurisdictional limitations due to their virtual nature; the price system is devolved to the level of the market; and it shifts the governance of economic activities from centralised institutions towards markets. As a result of this, MacDonald, et al. (2016, p. 286) note that blockchains would be considered catallaxies rather than economies from a Hayekian perspective, Although their research does not focus specifically upon Bitcoin, but rather the technological infrastructure underpinning it, it is a natural extension of their theory that cryptocurrency is one of the catallaxies spawned by the 'constellaxy' of the blockchain. Indeed, the cryptocurrency market shares many of the identifiable features of a catallaxy: it eliminates the need for states and central banks in the issuance of currency, as well as third parties in overseeing transactions; it is not limited by geographical boundaries; its economic factors such as prices are determined by market forces rather than hierarchical intervention; and it is constitutionally governed in the sense that certain rules are imposed by its technological infrastructure (Brito and Castillo, 2013; MacDonald, et al., 2016). These factors are significant in the context of this research, given that this thesis seeks to determine, in research question 2, the motivations behind individuals adopting Bitcoin in lieu of existing fiat currency regimes.

2.5. Empirical Case Studies of Risk-Averse Bitcoin Adoption

The third research question seeks to address whether or not a relationship exists between cryptocurrency prices and indices of consumer or investor confidence. Although analysis of this scale (i.e. at the world level) is not reflected in the literature, a number of national and regional case studies are suggestive that such a relationship may exist.

2.5.1. Risk-Averse Bitcoin Adoption during the Cypriot Financial Crises

In an analysis of the features that make Bitcoin attractive to users, Darlington (2014) outlines the profile of a country in which a cryptocurrency alternative would be most likely to gain traction. Such a country would likely be prone to hyperinflation or unstable monetary policies; have high levels of institutional corruption; and possess a large population of individuals who lack access to safe financial institutions. Darlington (2014) goes beyond simply providing a hypothetical template for a Bitcoin-receptive state, applying his profile to the contemporary example of Cyprus. From 2012 to 2013, Cyprus experienced a financial crisis brought about by the ripple effects of the US subprime mortgage crisis in 2008, the exposure of Cypriot banks to overleveraged property companies, and an increase in both public and private sector debt (Laeven and Valencia, 2013). As a result, Cypriot banks experienced a loss of confidence in their solvency which culminated in a downgrading of Cyprus' credit rating to junk status (Darlington, 2014). During the course of bailout negotiations with the European Union, the government proposed issuing a levy on the savings accounts of Cypriot citizens; a move which, although ultimately voted down, resulted in the loss of any remaining confidence in the banks (Laeven and Valencia, 2013; Darlington, 2014). Thus, Bitcoin came to be regarded as a viable alternative by many Cypriot citizens, with Darlington (2014) noting the emergence of a bank which backed depositor's Euros with a corresponding number of Bitcoins, along with a number of brick-and-mortar businesses accepting cryptocurrency as a method of payment.

2.5.2. Risk-Averse Bitcoin Adoption during the Greek Debt Crisis

Cyprus is not the only Eurozone nation to experience a tangible upsurge in Bitcoin trading, with research by Bouoiyour and Selmi examining its growth in Greece during the lead-up to the possibility of a Greek default in 2015. Although the research of Bouoiyour and Selmi (2015) focuses on addressing claims by then-Greek Finance Minister Yanis Varoufakis that Greece could adopt Bitcoin if the Eurozone did not offer a suitable agreement – a claim the authors describe as an "April Fools

prank" rather than a serious possibility. Nevertheless, the findings by Bouoiyour and Selmi (2015) point to a growth of Bitcoin in Greece during this period. Using Google and Twitter trends[15] to determine the correlation between discussion of the looming Greek default and the possibility of the country leaving the Eurozone (colloquially referred to as the "Grexit"), Bouoiyour and Selmi (2015) find that there was a short-term statistically significant relationship between search queries regarding the Greek crisis and Bitcoin. They find evidence of an increase in the adoption of Bitcoin by Greek citizens, despite dismissing the prospect of the Greek government leaving the Euro to do the same. Bouoiyour and Selmi (2015, p. 2) note that increased Bitcoin adoption "is well-seen from the Vaultoro [an internet platform where users can trade physical gold and Bitcoins] platform that [there was a] 124% pick-up in inflows from Greek IP addresses". In offering an explanation for this phenomenon, Bouoiyour and Selmi (2015, p. 2) argue: "This clearly indicates that the Greeks are worried and prefer to keep their savings in private assets like gold and Bitcoin that may constitute safe havens, rather than depending widely on the goodwill of banks."

2.5.3. Risk-Averse Bitcoin Adoption amidst Argentine Inflation

Finally, some attention should be given to the rapid adoption of Bitcoin within Latin-America, particularly in social-democratic political systems such as Argentina. While Argentina has a long and storied history of economic turmoil, recent decades have been marked by skyrocketing levels of inflation, currency devaluations, and dwindling foreign currency reserves (Ussing, et al., 2014). These underlying issues of currency devaluations and high inflation rates have driven a growing demand for foreign currencies and commodities to serve as a more reliable store of value, leading the Argentine government to impose strict controls to stifle the flight of capital into US dollars. Such

[15] Although the use of these metrics are not without their methodological faults, it bears noting that the research by Bouoiyour and Selmi (2015) focuses upon other topics, with their findings regarding private Bitcoin usage incidental to their discussion about the prospects of the Greek *government* adopting it as a currency. Given that Varoufakis raised the topic of Greece adopting Bitcoin, it seems intuitive that the cryptocurrency would see an upsurge in both Google searches and social media discussion within that country (Bouoiyour and Selmi, 2015).

policies include the criminalisation of the private sale of dollars, forcing Argentine citizens to purchase dollars from government agencies under particular circumstances (such as overseas travel) and a cap on the number of dollars that can be purchased in total (Ussing, et al., 2014). Although such policies simply fuelled even greater demand for foreign currencies on the black market, with the price of the "blue dollar"[16] topping at a black market exchange rate 70% higher than the official government exchange rate in 2014; it has also inadvertently resulted in making Bitcoin a much more viable alternative (Ussing, et al., 2014). Using publicly available market data, Ussing, et al. (2014) found that Argentina's share of the global Bitcoin trade increased from 0.7% to 3% in the six month-period in 2013, with this rise coinciding with a peak in the blue dollar exchange rate.

Further, employing a structured survey to engage Bitcoin users, Ussing, et al. (2014) found that the primary motivations for the adoption of cryptocurrency in Argentina fall into three broad categories: ideological reasons (relating to the growth of libertarian economic and political views in opposition to the socialist government); practical reasons related to Argentina's domestic monetary situation (the desire to find a more reliable store of value than the peso and the difficulties in securing an alternative due to strict currency controls); and speculative reasons (trying to make a profit from Bitcoin price fluctuations). Ussing, et al. (2014) find – with an importance of four or five survey points – that 44.4% of respondents use Bitcoin because it "challenges the authority of banks and governments"; 76.5% of respondents agree that restrictions on exchanging currencies are an important reason for their adoption of Bitcoin; and 82.9% of respondents adopt Bitcoin for the purpose of "protecting money from devaluation".

[16] The term "blue dollar" is an Argentine colloquial term referring to the black market exchange rate between the peso and other currencies. Due to strict currency controls imposed by the Argentine government, there is a notable disparity between the official exchange rate enforced by the government and the unofficial "blue dollar" exchange rate offered by the black market (Ussing, et al., 2014).

Although the three case studies reviewed above relate to different economic circumstances, they all share commonality in the increasing adoption of Bitcoin as an alternative medium of exchange during periods of declining confidence. These findings are pertinent to this research given that the influence of each scenario on Bitcoin remained the same despite the different conditions in each case study, with a sovereign debt crisis, a banking crisis, and rising levels of inflation contributing to an increased adoption of the cryptocurrency. In particular, the fact that each period of economic difficulty resulted in a corollary increase in Bitcoin's value lends credence to the notion that a statistically significant relationship between confidence and cryptocurrency prices could exist. Given that each case study is representative of different socioeconomic environments, the resultant influence on Bitcoin prices could be the result of a common variable, such as a decline in economic confidence. While the literature raises the possibility of a statistically significant relationship between confidence and Bitcoin prices, the impact of these scenarios on the value of other cryptocurrencies is neglected by all three studies reviewed.

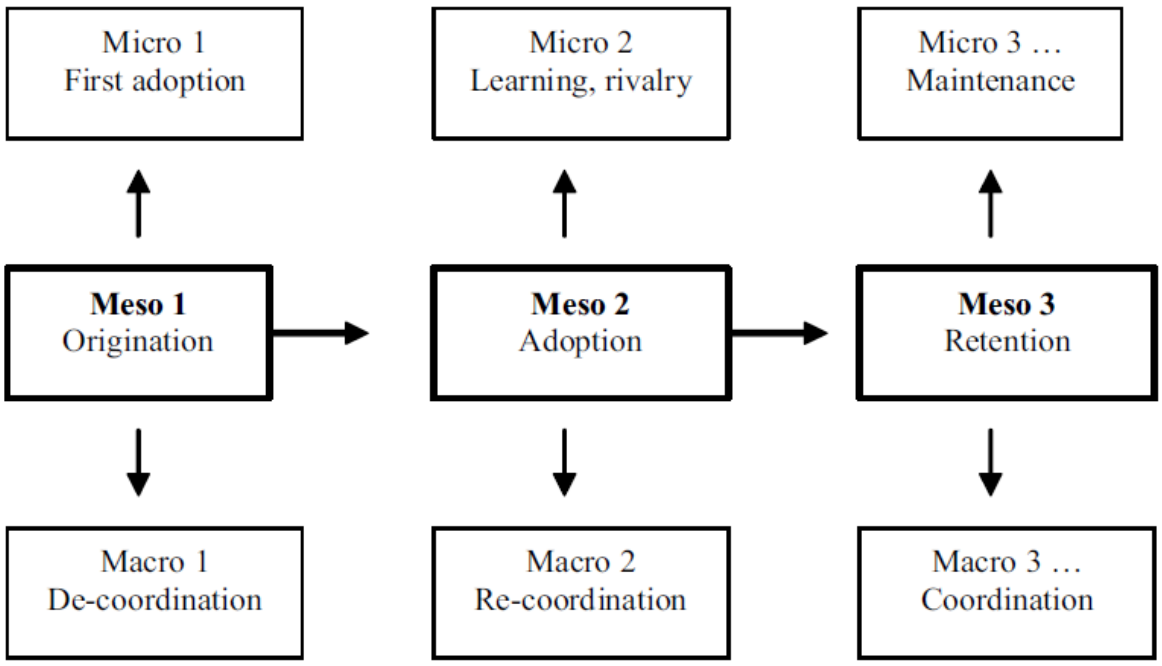
2.6. The Micro-Meso-Macro Framework

The micro-meso-macro (MMM) framework presented by Dopfer, Foster, and Potts (2004) will underpin this thesis. The framework builds upon Popper's (1945) historicist criticism of the social sciences, and what Dopfer, et al. (2004) dub Hayek's 'algebraicist' critique of mainstream economics. Dopfer, et al. (2004) maintain that a micro-macro division of analysis (under which the macro is the sum of the micro, and the former breaks down into the latter) cannot adequately explain a complex evolutionary system like the market. Conceptualising the economy as a complex system of rules, Dopfer, et al. (2004) introduce the meso as a third analytical domain between the micro and macro, with the relationship between these levels telescopic in nature. In essence, a generic rule and its population of actualisations constitute a meso unit, with a focus on single rules and individual carriers providing the micro perspective and an emphasis the aggregation of meso units affording the macro perspective.

As an example of this telescopic framework, consider the Bitcoin community which forms the focus on this research. At the micro level, there are the individual members; at the macro level, the community as a whole. The meso level consists of various rule units as individual actors who self-organise to innovate or achieve various objectives. Within this framework, the theories outlined throughout this chapter help contextualise the relationship between the layers at the micro, meso, and macro levels. For example, the notions of a knowledge or innovations common, or a market for preferences, as outlined in section 2.1, explains how individuals at the micro level join the broader Bitcoin community as carriers of a generic rule. Likewise, an overarching system such as a catallaxy illustrates the manner in which these meso units can come together to comprise an economic system at the macro level. However, missing from this discussion is the evolution of a system.

Far from simply introducing an additional layer of analysis, the MMM framework provides a lens for understanding the evolution of the market within the context of social institutions. Since Dopfer, et al. (2004) regard the micro and macro levels as components of an analysis as opposed to distinct domains, they maintain that evolution in the market and its institutions can best be understood from the meso perspective. In particular, they identify a meso trajectory of three distinct stages: origination, diffusion, and retention. The origination stage consists of an agent developing a new rule which results in the creation of new institutions. The diffusion stage consists of a process of adoption and adaptation, whereby the new rule is implemented within a number of organisational contexts. Finally, the retention stage occurs when the rule has been successfully implemented, and continues to be maintained and adapted as needed. As per the telescopic nature of the MMM framework, each stage has implications at the micro and macro levels, which are illustrated in Figure 2.1.

Figure 2.1: The Analytical Structure of a Meso Trajectory



Source: Dopfer, et al. (2004, p. 273)

In applying this trajectory to Bitcoin, it must be noted that cryptocurrency has not yet reached the retention stage of its evolution, for the same reasons that it has not reached the later stages of the Rogers (2003) scale of adoption outlined in section 2.1. However, the origination and adoption phases are of particular relevance to this research. In the origination stage, Nakamoto (2008) outlines and implements a cryptocurrency model that solves the double-spending problem, resulting in early adopters at the micro-level and the creation of a new market at the macro-level. Furthermore, the competition generated by cryptocurrency results in de-coordination amongst established institutions. This is not to say that established institutions are having their dominance threatened, but rather that the blockchain technology raises implications regarded their operations that must be grappled with in this phase. Bitcoin is currently in the adoption stage, with the emergence of a cryptocurrency market and community that constitutes the focus of this research. At the micro level, new forms of knowledge are created (e.g. the Bitcoin community, whether as a

commons or a market for preferences) and competition occurs (e.g. experimentation with altcoins). Meanwhile, at the macro-level, re-coordination occurs through the creation of new institutions (e.g. the emergence of institutional entrepreneurship).

The MMM framework is applied throughout this thesis as a means of interpreting the research findings, with various theories presented throughout this review utilised in the telescopic shift between layers. Such analysis will only apply the MMM framework for the first two stages, as Bitcoin has not yet reached the retention stage and hypothesising about it falls outside the scope of this thesis. Finally, it should be noted that the MMM framework will form the basis of the discussion in Chapter 7 but it will not form a major component of the empirical research chapters. These earlier chapters will be used to present the empirical findings without a running commentary, as the interconnected nature of the research questions and methodological approaches necessitates their discussion in conjunction with one another.

2.7. Summary

In presenting the extant body of literature, this review has had a wide-ranging focus, examining Bitcoin from a number of different perspectives that are useful for the forthcoming analysis. Furthermore, by outlining the research landscape, it is possible to justify the research questions and ground them in the body of work. In particular, this review examined literature adhering to five overarching topics (which in turn contain a number of more specific subcategories): defining the Bitcoin community; exploring the role of Bitcoin in the market; examining its function as a hedge; detailing cryptocurrency within an institutional end evolutionary context; and outlining case studies of risk-averse adoption. While there are a number of ways to interpret Bitcoin as a tool for investment, the research outlined in Section 2.3 shows that, in terms of RQ1, hedging is a justifiable area of research focus. Likewise, RQ2 is well grounded both in terms of this gap and the evolutionary

research outlined in Section 2.4. Finally, RQ3 on confidence extrapolates from the case studies detailed in Section 2.5, although it adopts a broader focus and is not bound by the cited research. Finally, this review establishes the micro-meso-macro framework as an interpretative lens for analysing the empirical findings of this thesis. With these factors outlined, the next chapter will present the methodological underpinnings of this research.

3. Methodology

This chapter presents the methodology for the empirical component of the thesis, which consists of a multi-stage, mixed methods approach. In particular, the research employs a semantic analysis, a survey analysis, and an econometric analysis, the findings of which are presented in Chapters 4 through 6, respectively. It should be noted that neither the research questions nor these methodological approaches are intended to be self-contained and distinct, but are complementary. As such, the empirical findings are presented across the aforementioned chapters within the context of the interpretative framework set out in Chapter 2. This chapter is structured in four parts, with section 3.1 explaining how the interpretative framework will be applied; sections 3.2 through 3.4 detailing the semantic analysis, the survey analysis, and econometric analysis, respectively; and section 3.5 provides a summary.

3.1. Applying the Interpretative Framework

Embedded within each of the research questions outlined in section 1.2 is an assumption that Bitcoin and the community of its users are dynamic and evolving systems that cannot be understood without an acknowledgement of change occurring over time. As such, the micro-meso-macro (MMM) framework outlined in section 2.6 provides the best interpretative lens for analysing the data collected through each methodological approach. The research assumes that the Bitcoin market and community are evolving along a meso trajectory encompassing the origination and retention phases, but have not yet reached the retention phase of their development. As such, the discussion employing the MMM framework in Chapter 7 will only focus on these two stages. Upon presenting the empirical findings in Chapters 4 through 6, the discussion will employ a triangulation method, using relevant data drawn from each methodological approach to address the research questions (Flick, 2004; Lauri, 2011). Due to the telescopic nature of the MMM framework, theories

outlined in Chapter 2 will then be utilised where appropriate to interpret and contextualise the data at both the micro and macro levels along the meso trajectory.

3.2. Semantic Analysis

Chapters 4 and 5 of this thesis employ different methodological techniques. However, both are interlinked in a multi-staged approach, with the former employing a semantic analysis that forms the basis of the survey presented in the latter. As such, while the semantic analysis is outlined in section 3.2, the justification for this methodological approach is set out in section 3.3.3.

3.2.1. Data Collection

Targeting the online Bitcoin message board, Bitcointalk.org, the data obtained will be subjected to a semantic analysis. This is a methodological approach which extracts the informational content of a text-based data source by breaking it down into its linguistic components (Goddard, 2011). Such a methodological approach was utilised by Teigland, et al. (2013) in their examination of institutional entrepreneurship within the Bitcoin community. This thesis adopts a similar approach, modifying the methodology employed by Teigland, et al. (2013) to better address the different research focus of this thesis. Employing custom webscraper software, this research collates all the English posts on the Bitcoin forums from November 22nd 2009, when the first message was posted, to the date at which the research commences. This produced a sample of approximately 13.7 million posts from 862,298 individuals across a six-and-a-half year period. Each individual word is then extracted and assigned to a matrix tracking its usage over time by employing the Stanford Long-linear Part-of-Speech Tagger, which breaks down the individual terms into their lexical categories (Toutanova, Klein, Manning, and Singer, 2003). Once a word list is compiled, the research takes the top 10,000 words in each category (nouns, proper nouns, verbs, adverbs, and adjectives), and isolate terms which fall within three categories relevant to the research topic: investment-related terms; external economic risks

(hazards which impact upon the mainstream economy); and internal economic risks (hazards which are more specific to the cryptocurrency market).[17]

3.2.2. Data Analysis

This research adopts a focus on how often the specific topics of interest feature in conversations. In particular, this research seeks to extract generic[18] terms which fall within the three broad categories identified in section 3.2.1. Upon extracting these relevant topics of conversation, each *n*-gram (selected word) is charted across a time series which tracks their frequency of use per month, allowing the research to determine when a topic receives a higher-than-average volume of discussion traffic. Once these peaks are identified, the research cross-references each *n*-gram with an archive of forum posts across the same period in order to determine the cause of the resultant increase in community discussion.

Following the completion of the semantic analysis, this research constructs a semantic network map employing each of the chosen *n*-grams in order to determine the relationship between variables. Semantic network analysis is a methodological approach which serves to identify the central factors within a data source and provide an empirical determinant of the extent to which they relate to one another (Doerfel, 1998). Each *n*-gram from the previous semantic analysis is identified as a node within a larger network, with a series of edges connecting them to one another in a map of their social relationships. The edges connecting the nodes are weighted based upon the strength of the social relationship between the two *n*-grams, with this being identified by the total number of times

[17] It must be noted that this distinction between "internal" and "external" forms of risk is a narrative decision to provide structure to the discussion surrounding the research findings. The use of these terms should not be interpreted as denoting a technical or theoretical distinction between the two.

[18] Generic terms refer to words which can be employed to describe a number of topics without being limited to a specific focus on a particular incident. For example, the generic term "Ponzi" is used as a dragnet to collect all conversations related to that topic, as opposed to more specific terms such as "Trendon Shavers" which would only produce data on that particular Ponzi scheme.

a post in the forums contains both *n*-grams. Terms with a long social distance (a higher number of shared posts indicating strong intersectionality between topics) are identified by more defined edges, whereas the opposite is true for words with a short social distance (fewer instances of shared posts indicating minimal intersectionality). Upon construction of the network map, the data will be analysed with reference to the connections between investment-related *n*-grams and risk-related *n*-grams, rather than intra-topic relationships, allowing this research to determine how investors appreciate forms of economic risk based upon their activities. Edges which demonstrate a long social distance between an investment-related activity and a form of internal or external economic risk are cross-referenced with archived forum posts which contain the two *n*-grams, allowing the researcher to determine how and why these topics are related. Unlike the prior semantic analysis, which only examined archived forum posts during periods of above-average discussion traffic, here the semantic network analysis examines posts across all periods due to the narrower and more refined search parameters.

3.3. Survey Analysis

With the conclusion of the semantic analysis, the key topics of discussion are reviewed by applying the interpretative framework in order to inform the questions constructed in the three-part survey posted to the Bitcoin forums.[19] Particular focus is given to observations from the semantic analysis data which are relevant to the research questions, and cannot be explored any further through that particular methodological approach.[20]

[19] The survey format was approved by the Federation University Human Research Ethics Committee on the 1st April 2017, with the reference number of B16-181. The approval letter is attached in Appendix A. The Final Report has been submitted in accordance with the research guidelines.

[20] The specific questions asked in the survey and a breakdown of their responses can be found in Appendix C.

3.3.1. Data Collection

The first part of the survey consists of questions relating to basic demographic information, such as age, country of origin, political views, and level of education, allowing for the information derived to be grounded in data on the individual respondents. Secondly, the survey lists a number of features of Bitcoin and asks respondents to rate their importance to them on a scale of one to five. This section includes those features that make Bitcoin valuable or useful to respondents; the forms of risk they are most concerned about, including examples of what this research has dubbed "internal" and "external" risks; and their level of trust in institutions relating to the cryptocurrency market, governments, central banks, and the mainstream financial system. Finally, the survey concludes with a section asking a series of open-ended short answer questions about the motivations of respondents in adopting the use of Bitcoin, the manners in which they utilise it, and their biggest areas of concern. This open-ended format allows respondents to delve deeper into the topics being analysed, and could yield insights unconstrained by the researcher's expectations in crafting the survey.

Due to the aforementioned difficulties in reaching the pseudonymous and globally-diffused Bitcoin user base, the research once again targets online communities for data collection. The first of these is Bitcointalk.org, the same online message board that was employed in the semantic analysis in order to provide a means of cross-checking the findings derived from that phase of the analysis. However, the survey also targets another website identified by Smyth (2014) as a popular meeting point for cryptocurrency users: Reddit. In particular, the survey is posted on two different Bitcoin-related subreddits, r/Bitcoin and r/BTC. The inclusion of these two different subreddits is important for ensuring a degree of ideological diversity amongst respondents, given the history of these two Reddit communities. Whereas r/Bitcoin was the original home for cryptocurrency discussion on Reddit, a number of its members felt that the moderators were disproportionately suppressing

viewpoints that they did not agree with – particularly in regard to the blocksize scaling debate.[21] Subsequently, those individuals who felt that r/Bitcoin was not providing a free environment in which to express their views broke away to establish r/BTC, where such discussions could continue free of moderator interference. As such, incorporating both of these subreddits helps to reduce some of the sampling bias inherent in targeting online communities, ensuring that any partisan biases reflected within the sample are not merely reflective of one group to the exclusion of others in the broader Bitcoin user community. The thesis employs LimeSurvey for the purpose of collecting data, generating a sample of 294 respondents who completed the survey and an additional 88 who provided partial responses. Employing the SurveyMonkey (2017) Margin of Error Calculator, it is possible to determine the extent to which such a sample is representative of the target sites. At the time of data collection, Bitcointalk.org had 971,943 members, while r/Bitcoin and r/BTC had 215,461 and 32,588 subscribers respectively. Assuming a confidence level of 95%, this means that any results interpreted using all respondents have a margin of error of +/-5%, while findings from only the completed responses possess a margin of error of +/-6%[22].

3.3.2. Data Analysis

Once a satisfactory sample size is reached, the survey findings are presented and subjected to multiple stages of analysis. Note that due to the lack of information regarding the social make-up of the Bitcoin community, the raw data is not weighted based on demographic factors. There are no known inequalities to correct for by using weights – or, perhaps more accurately, due to the paucity of research regarding the composition of the cryptocurrency user base, the data cannot be grounded

[21] Due to its technological nature, each contribution to the blockchain consists of data, with a cap on the maximum amount of 1 MB of data allowed per block. As the Bitcoin user base has grown, critics argue that this artificial cap arbitrarily limits the number of transactions that can be processed, slowing down the network and increasing costs. However, proponents argue that it is necessary to keep it in place for a number of reasons; a debate which is covered in greater depth later in this thesis.

[22] At this point, it should be acknowledged that the data provided from the 88 partial responses will only be utilised during the initial data analysis stage for sections one and two of the survey. All further stages of research, including the cluster analysis, will rely upon the 294 complete responses.

in prior literature without carrying the risk of compromising scientific validity.[23] Once the survey results are presented and observations are made, the data is subjected to cluster analysis, a statistical method of identifying areas of commonality between individuals and dividing a large group into subgroups or "clusters" based on these unifying traits (Kaufman and Rousseeuw, 2015).

Focusing specifically on section three of the survey, respondents have their answers assigned to a category (e.g. mainstream risk-averse, cryptocurrency risk-taking, etc.) and given a score based on the percentage of their responses that fall within each group. Individual respondents are then assigned to a series of 'clusters,' which are representative of subgroups within the total sample characterised by a high level of commonality between their indicated views and behaviours. Put simply, individuals whose answers in section three indicate a certain behavioural archetype are assigned to a cluster with other respondents, with those sharing the same clusters possessing statistically significant commonality in their answers, compared to those in other groups with whom they share only minimal to moderate commonality (Kaufman and Rousseeuw, 2015). This allows the research to not only identify the commonality and divergence between different subgroups of respondents, but also the extent to which certain views are broadly shared and which are statistical outliers.

Upon dividing the respondent pool into clusters based on shared risk appreciation and investment behaviour, the research identifies any demographic factors which appear to determine belonging to a particular subgroup. The analysis then employs the demographics of the survey pool as a whole as a baseline figure to compare the demographics of each cluster, allowing the research to identify any factors which are disproportionately overrepresented or underrepresented within the subgroup.

[23] Although the original demographic analysis by Smyth (2013) offered insights into the social composition of the Bitcoin user base, its methodological limitations and lack of broader replication throughout the corpus of literature means that it cannot be cited as a justification for weighting results, lest doing so exposes this research to untested biases.

Additionally, cluster demographics are compared to one another to identify any points of convergence or divergence in regard to these influential demographic drivers of group identity.

3.3.3. Justification for the Semantic Analysis and Survey Methods

One of the main issues that this research has had to contend with is the fact that the pseudonymous, decentralised, and globally diffuse nature of the Bitcoin user base makes it difficult to accurately derive primary data. Although, as evidenced by the methodological approach, there are online communities that can be targeted for data collection, there are likewise many users who do not engage with these groups and remain unidentifiable. This underlying issue of ensuring a representative sample of user-derived data is further exacerbated by the limitations of each methodological approach. For instance, semantic analysis allows data extraction from a greater number of individuals than could possibly be reached via a survey, but it is limited to passive observation of conversations that have emerged in a setting without any interaction between researcher and subject. Conversely, the survey approach allows for this interactive engagement and a more targeted approach to data collection, but suffers from a reduced reach in terms of the total number of respondents. By combining the two, the research adopts a “triangulation approach” to data collection, the utilisation of multiple methodological tools which each reinforce the strengths and compensate for the weaknesses of each other (Flick, 2004; Lauri, 2011). In this particular context, the semantic analysis compensates for the limited reach of the survey while the survey addresses the lack of an interactive exchange between researcher and subject, with a comparison of findings between the two serving to support or refute any derived conclusions.

The issue of accessibility in regard to data derived from the Bitcoin user base likewise has implications relating to the survey sample and the extent to which it can be considered representative. With respect to the issue of some Bitcoin users not engaging with online communities in any way, thus making any findings derived potentially unreflective of their views,

this is addressed by the primary research focus on members who perceive themselves as part of a broader cryptocurrency community. However, ensuring that the community itself is accurately reflected in the data, rather than certain sections of it, is of particular importance when it comes to deriving accurate findings. This issue is largely addressed by the targeting of multiple websites for the survey approach, unlike the semantic analysis, which is limited to analysis of a single online message board. By broadening the scope of data collection to multiple online forums, the research can compensate for any sampling biases which arise as a result of particular subgroups or subcultures which congregate on a single site. An example of this is the inclusion of both the r/Bitcoin and r/BTC subreddits, which have broad disagreements on a number of issues as a result of the ideological schism detailed in section 3.3.1. By including both groups in the survey, the research ensures that the data is not skewed in favour of the views of one particular group when questions overlap with issues in which the two disagree, ensuring a more representative sample of the overall community.

3.4. Time-Series Econometric Analysis

In the third methodological approach, the research employs time-series data to determine the existence of any statistically significant relationship between cryptocurrency prices and indices of economic confidence.

3.4.1. Data Collection

The research employs data from both Bitcoin and its competitor Ethereum, the second-largest cryptocurrency in terms of market share, as variables. The data for each is sourced from CoinDesk, an online news source which provides cryptocurrency data and research including a series of price indexes. Specifically, the data is derived from the CoinDesk (2017a) Bitcoin Price Index and the CoinDesk (2017b) Ethereum Price Index, which expresses the value of each cryptocurrency across a time series in USD based upon the price at the close of day. Deriving such data from CoinDesk is not

without precedent in the extant body of literature, as it is one of, if not the most commonly cited source of price information available (Brito, Shadab, and Castillo, 2014; Cheah and Fry, 2015; Eisl, Gasser, and Weinmayer, 2015; Katsiampa, 2017). At this point, it should be noted that while the confidence indices employed in this research are calculated on a monthly basis, CoinDesk provides cryptocurrency prices on a daily basis – although, for some of the earlier periods, this data is only provided on a weekly and eventually bi-weekly basis. As such, to ensure consistency between the data sets, the values of each cryptocurrency have been adjusted by calculating the median price for each monthly period.

While the various case studies identified in the literature review demonstrate the possibility of confidence affecting Bitcoin prices in a national or regional context, this research seeks to determine whether such observations translate to a relationship between prices and confidence on a broader scale. As such, the research relies on national and organisational data from leading world economies which serve as a bellwether of global trends, allowing for an approximation of the area of focus. The data itself is sourced from the Organisation for Economic Cooperation and Development's (OECD) leading indicators of consumer and investor confidence, namely the OECD (2017a) Business Confidence Index and the OECD (2017b) Consumer Confidence Index.[24] With regards to the former, both the United States and the OECD as a whole are employed as variables. The inclusion of the United States owes to its position as the world's leading economy and a subsequent driver of global markets, making it a reliable if imperfect approximation of the trends being analysed in this research (Ripley, 1973; Schollhammer and Sand, 1985; Becker, Finnerty, and Gupta, 1990; Eun and Shim, 2009). The inclusion of the OECD follows a similar logic but expands the scope of analysis to include a number of major economies around the world, including North America, Europe, and to a lesser extent, portions of South America and the Asia-Pacific region. As for consumer confidence, only the

[24] The shifts in confidence across OECD member states are weighted per the methodology outlined by Brunet and Nilsson (2005).

OECD is employed as a variable due to the OECD (2017b) Consumer Confidence Index being primarily focused on and presenting data with reference to this broader grouping. The period of analysis for each variable is from August 2010, when the volume of trade in Bitcoin grew significant enough for analysis, to September 2017. The only exception is Ethereum, with the data comprising the September 2015 to September 2017 period.

3.4.2. Data Analysis

Once the data has been collected and established across a time series, this research subjects it to three primary stages of analysis – cross-correlation analysis, Johansen cointegration testing, and Granger causality testing – ensuring that, should economic confidence prove to have an effect on cryptocurrency prices, it is possible to quantify the extent of this relationship. However, before these tests can be applied, the data must first be tested and if necessary adjusted for stationarity to ensure that it does not exhibit any random-walk or drift characteristics, follow a trend, or contain a unit root. Such stationarity adjustments are particularly important, as most forms of raw economic data exhibit at least some of these characteristics, and, as noted by Iordanova (2016, p. 4) "The results obtained by using non-stationary time series may be spurious in that they may indicate a relationship between two variables where one does not exist." The method the research employs to test for stationarity is the Augmented Dickey-Fuller (ADF) test, which identifies the aforementioned characteristics in the data by testing for the presence of a unit root (Dickey and Fuller, 1981). As per the recommendations of Dolado, Jenkinson, and Sosvilla-Rivero (1990), this analysis employs the most unrestricted model of the ADF including both a trend and an intercept, which involves estimating the following regression for each variable with the null hypothesis being that the data is non-stationary:

$$\Delta y_t = \alpha_i y_{t-1} + x_i{}'\delta + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \cdots + \beta_p \Delta y_{t-p} + \vartheta_t - - Equation\ (3.1)$$

In this equation, α is a constant representing the potential drift of the data series, β is the coefficient on a time trend, p is the lag order of the autoregressive process, and Δ is the first difference operator. In the event that non-stationarity is determined due to the presence of a unit root, the data is then adjusted by taking the first difference in the series and applying the ADF test again, with this process being repeated until no unit root is found (Greene, 2012).

Once the data has been adjusted for stationarity, it can be more accurately analysed in order to determine whether or not there is a statistically significant relationship between the chosen variables. As a preliminary method of inquiry, the research employs cross-correlation testing to determine the extent to which the variables move in concert with one another across a time series. In order to accomplish this, pairs of variables are input into a cross-correlogram in order to calculate the correlation coefficient across multiple lags. Determining the correlation coefficients of delaying and advancing l periods between series *x* (cryptocurrency prices) and series *y* (indices of confidence) requires estimation of the following equations:

$$r_{xy}(l) = \frac{c_{xy}(l)}{\sqrt{c_{xx}(0)} . \sqrt{c_{yy}(0)}};\ \ where\ l = 0, \pm 1, \pm 2, \dots Equation\ (3.2)$$

Where r_{xy} is the correlation coefficient between $c_{xx}(0)$ and $c_{yy}(0)$, c_{xy} is the cross-covariance, and $c_{xx}(0)$ and $c_{yy}(0)$ are the own variances.

$$c_{xy}(l) = \begin{cases} \sum_{t=1}^{T-1} \frac{((x_t - \bar{x})(y_{t+1} - \bar{y}))}{T}; & where\ \ l = 0, 1, 2, \dots \\ \sum_{t=1}^{T+1} \frac{((y_t - \bar{y})(x_{t-1} - \bar{x}))}{T}; & where\ \ l = 0, -1, -2, \dots Equation\ (3.3) \end{cases}$$

Where $\bar{x}$ and $\bar{y}$ are the means of each time series and there are T samples.

Applying these equations to the data sets produces a correlation coefficient of either positive or negative value, depending on whether the variables co-move in the same or opposing directions

across each lag in the time series. If the co-movement between the variables is positive, the strength of the relationship determines the value of the coefficient on a range from 0.0000 to 1.0000. Conversely, if the co-movement is negative, the same determination applies with the range being from 0.0000 to -1.0000.

Upon determining the level of cross-correlation between the variables, the analysis then applies the Johansen (1991) cointegration test. This is a more robust method of quantifying the co-movement of variables across a time series utilising the non-stationary data, as the calculations involved apply error correction to the variables. To be able to apply cointegration tests and ECM models, the data has to be stationary at first difference or integrated of order 1 (e.g. I(1)). This order of integration or stationarity is confirmed using the ADF test. Prior to applying the cointegration test, the optimal lag length between each data set, which is accomplished by using the vector autoregression (VAR) lag order selection criterion. Five different selection criterion are employed through this approach - the likelihood ratio (LR) test statistic, the final prediction error (FPE), the Aikake information criterion (AIC), the Schwarz information criterion (SC), and the Hannan-Quinn information criterion (HQ) – with the optimal lag determined by the concurrence of the majority of these specified tests (Lutkepohl, 1991). The optimal lag is then applied to the data sets, which involves estimating the following regression with the null hypothesis that the variables are not cointegrated:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + Bx_t + \epsilon_t \text{ ---------- } Equation\ (3.4)$$

In this regression, y_t is a *k*-vector of non-stationary variables, x_t is a *d*-vector of deterministic variables, and ε_t is a vector of innovations. Assuming that there is a linear deterministic trend in the data, the cointegrating equations have only intercepts, which requires applying the following specification derived by Johansen (1995) as a subset of the previous equation:

$$H_t(r): \Pi y_{t-1} + Bx_t = \alpha\left(\acute{\beta} y_{t-1} + \rho_0\right) + \alpha_\perp \gamma_0 - - - Equation\ (3.5)$$

In this regression, $\alpha_{\perp}$ is a null space of α which denotes the deterministic trends independent of the cointegrating relationship, while the trends that are part of the error correction term are identified by regressing the cointegrating relations $\acute{\beta} y_t$ on a constant and linear trend (Johansen, 1995).

In data sets where the null hypothesis has been rejected and cointegration is determined, a vector error correction model (VECM) is employed to derive a cointegrating equation, quantifying the co-movement relationship between the variables. VECM is a restricted vector autoregression (VAR) that explores the long-run relationship between non-stationary data sets which are identified as being cointegrated, and can also suggest short-run relationships (Johansen, 1995). For example, in a system with two variables which have one cointegrating equation and no lagged difference terms, the cointegrating equation can be expressed as:

$$\gamma_{2,i} = \beta\gamma_{1,i} - -Equation\ (3.6)$$

Based on this equation, the corresponding VECM for each cryptocurrency is:

$$\Delta\gamma_{1,i} = \alpha_1(\gamma_{2,i-1} - \beta\gamma_{1,i-1}) + \varepsilon_{1,i} - -Equation\ (3.7)$$

$$\Delta\gamma_{2,i} = \alpha_2(\gamma_{2,i-1} - \beta\gamma_{1,i-1}) + \varepsilon_{2,i} - -Equation\ (3.8)$$

In these two integrated equations, ε is an error correction term, the value of which is 0 in the long-run equilibrium. However, if γ_1 and γ_2 deviate from the long-run equilibrium, the value of ε is non-zero and the other variables are adjusted in order to partially restore the equilibrium relationship. α_i is a coefficient measuring the speed of adjustment of the *i*-th endogenous variable towards the equilibrium. Although it is possible to derive cointegrating equations for each variable, the analysis only determines the extent to which cryptocurrency prices move along the time series with indices of confidence, as the former is too small to have any influence on the latter in any statistically significant manner (Seetharaman, Saravanan, Patwa, and Mehta, 2017).

Although the previous tests are useful for quantifying the extent to which variables move together across a time series, they provide no indication as to whether one variable causes movement in the other, and vice versa. In order to accomplish this, a Granger causality test determines how useful the changes in one variable are in predicting the future values of another. This does not test for a true cause-and-effect relationship, but rather quantifies the extent to which one variable can provide relevant information about the future changes to another (Holland, Glymour, and Granger, 1985; Blalock, Jr., 2017). Expressed in the simplest of terms, variable X can be said to Granger-cause Y if the past values of X offer a statistically significant amount of information in regard to Y's future values (Granger, 1969). This assumes that indices of confidence are independent variables and cryptocurrency prices are dependent variables, as the size of the cryptocurrency market is too small to influence confidence in the mainstream economy in any substantial manner (Seetharaman, et al., 2017). Thus, the Granger causality test determines a unidirectional relationship between the variables, which involves estimating the following regression with the null hypothesis that X does not Granger-cause Y:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \cdots + \alpha_l \Delta y_{t-l} + \beta_1 x_{t-1} + \cdots + \beta_l \Delta x_{t-l} + \epsilon_t - -Equation\ (3.9)$$

In order for the null hypothesis to be rejected, the coefficients of lagged X must be statistically different from zero. Furthermore, since the results of the Granger causality test are highly sensitive to the number of lags included in the calculation, the analysis applies the test across multiple lags in order to compensate for phenomena such as a delayed feedback effect.

3.4.3. Justification for the Econometric Analysis

Particular attention should be given to the variables themselves, given that the research findings are contingent upon those employed. Utilising the variable of confidence, which is reflective of sentiment as opposed to more impartial and empirical measures of economic performance, allows the research to factor in the human element that may be influential in cryptocurrency adoption: a

primary focus of the research questions. The US and OECD indicators serve as the closest reliable approximations of global confidence. The limitations of using a single country as a metric for international trends is additionally compensated for by the inclusion of the OECD as a variable, which provides data encompassing multiple leading economies spread across several continents. As such, the use of these variables in the analysis provides the research with a reliable if imperfect approximation of the phenomenon being studied.

Use of two specific cryptocurrency variables likewise merits attention, as this section of the research expands the focus beyond Bitcoin to include its main altcoin competitor. The inclusion of Ethereum is owed at least in part to the fact that CoinDesk (2017a; 2017b), the most reliable and frequently cited source of price data, focuses predominantly on Bitcoin and its largest competitor to the exclusion of other altcoins. However, expanding the scope of analysis to encompass Ethereum is further justified by its rapid growth in terms of market share despite its short lifespan (CoinMarketCap, 2020). At this point, it should be acknowledged that other altcoins, such as Litecoin and Dogecoin, have been employed as variables in previous studies within the extant body of literature (Gandal and Halaburda, 2014; Chen, Chen, Hardle, Lee, and Ong, 2018). However, these cryptocurrencies have declined significantly in terms of market share since those studies were conducted, making Ethereum the best choice for inclusion in this research.

3.5. Summary

With the micro-meso-macro (MMM) framework underpinning the analysis, the thesis employs a methodology consisting of three parts: semantic, survey, and econometric analyses. The findings of the first of these data analysis methods, the semantic analysis of an online Bitcoin forum, is presented in the following chapter.

4. Semantic Analysis

This chapter presents the findings of the semantic analysis outlined in section 3.1 of the methodology. The data employed for analysis in this chapter is derived from an online message board and forum, which contains a vast body of information from members of the Bitcoin community. Due to the sheer size of the data[25] employed, this chapter will adopt a broad narrative approach, using only a few direct quotations that represent patterns emerging from the data, to ensure concise presentation of information. These patterns are presented in the various figures throughout this chapter with quotations providing context to such patterns. The findings of this semantic analysis are not intended to be viewed in isolation, and will instead be complemented by a survey in Chapter 5. This chapter is structured in seven parts. Section 4.1 outlines the collected data and how it is going to be employed throughout this analysis; sections 4.2 through 4.4 analyse the data compiled on external economic risks, internal economic risks, and investment-related terms, respectively; section 4.5 presents a semantic network map that explores the interrelationships between these chosen topics; section 4.6 will apply these findings to the MMM framework; and section 4.7 summarises the key findings of the chapter.

4.1. Data Collection

Employing the online message board Bitcointalk.org as the target sample for semantic analysis, this research utilised customised webscraper software to collate all English language posts during the period from the 22nd November 2009 to the 17th July 2016. With a sample size comprising of approximately 13.7 million posts from 862,298 individual members of the forum, each individual

[25] The raw data derived from the webscraper software comprises tens of thousands of pages, and requires specialised tools to sift through for analysis. As such, it has not been attached as an appendix. It should be noted that bitcointalk.org is a publicly accessible website.

word[26] used during discussion was extracted and assigned to a matrix which charted their mentions over time. Utilising the Stanford Log-linear Part-of-Speech Tagger (Toutanova, et al., 2003), each matrix was then attached to a list depending on the type of word (noun, proper noun, verb, adverb, or adjective), with a cut-off point for the 10,000 most commonly used words in each category.[27] With the data sets thus defined, each list was searched in order to identify and extract words which fell within the following parameters: terms relating to specific forms of economic risk; terms relating to specific forms of investment activity; and terms relating to alternative forms of investment.. Although the word lists for nouns, proper nouns, and verbs produced findings meriting further analysis, no relevant information was derived from adverbs and adjectives.[28] Fourteen terms within these categories were identified, which can be defined as adhering to three identifiable factors: investment-related activities, external economic risks (those relating to the mainstream economy), and internal economic risks (those related specifically to the Bitcoin economy). These topics are outlined in Table 4.1.

[26] In order to prevent the unnecessary duplication of words, the software employed broke each word down into its simplest form, merging the matrices for plurals and different tenses. For example, the words "hacks," "hacked," "hacking," and additional variations thereof were combined under the word "hack" in the matrix. In instances where the dictionary employed by the software did not recognise particular words and their variations, the entries were merged manually before being presented in this research.

[27] Upon analysis of each list, this cut-off point was raised farther to the 1,000 most commonly used words in each category, since words that fell below this threshold were employed in statistically insignificant amounts over the target period.

[28] The lack of useful information from adverbs and adjectives can most likely be attributed to the nature of linguistic structure. Whereas nouns, proper nouns, and verbs define a topic or describe an action, adverbs and adjectives provide additional context on the principal topic under discussion, making them less relevant in this type of analysis (Baker, 2003).

Table 4.1: Topics of interest derived via semantic analysis

Topic	Discussion Type	Word Type	Number of Mentions	Discussion Peak
Scam	Internal Risk	Noun	172,150	July 2014
Investment	Investment-Related	Noun	124,506	June 2016
Gold	Investment-Related	Noun	86,461	June 2016
Altcoins[29]	Investment-Related	Noun	78,931	January 2014
Steal	Internal Risk	Verb	68,866	March 2014
Security	All[30]	Noun	64,253	March 2014
Debt	External Risk	Noun	31,840	August 2014
Inflation	External Risk	Noun	31,715	July 2014
Speculation	Investment-Related	Noun	25,949	March 2014
Default	External Risk	Noun	21,829	January 2014
Ponzi	Internal Risk	Proper Noun	34,263	January 2015
Hack	Internal Risk	Verb	17,528	March 2016
Volatility	Internal Risk	Noun	14,843	March 2014

Source: Author's data derived from webscraping of Bitcointalk.org.

In outlining these conversation topics, a number of preliminary trends are identifiable. Firstly, with the exception of the internal economic risk of "scams," discussions on investment-related activities are more prominent than those related to conditions which might promote a risk-aversive mentality. However, conversations regarding "speculation" are less frequent than similar relevant terms, despite the practice being widely regarded as a driving force behind investment in Bitcoin by the academic literature (Bouoiyour, Selmi, and Tiwari, 2015; Cheah and Fry, 2015).[31] Secondly, the economic risks that can be identified as internal (specifically relating to the Bitcoin economy) appear

[29] Time series data on the specific altcoins used in this research, as well as Ethereum, were extracted during semantic analysis. However, as they were identified as sub-topics under the broader factor of "altcoins," they were omitted from this table.

[30] The sole exception to these categorisations was the term "security," which can readily be applied in discussion to all three primary topics, although additional context on its usage will be provided in the following discussion.

[31] Despite the popular perception of Bitcoin-related investment being predominantly driven by speculation, other sources have presented data to counter this claim (Wilson and Yelowitz, 2015).

more frequently above the cut-off threshold than those relating to external economic pressures. Although this could be construed as Bitcoin users adopting an increasingly inward focus once these risks begin to impact them, it must be noted that there is a certain degree of intersectionality between a number of these topics.[32] This issue, in turn, raises the fact that while isolating the key topics of interest allows for the identification of major concerns in the Bitcoin community, these subjects must be framed within the context of how they are being discussed. As such, each topic has been charted across a time series[33] in order to determine the peaks and troughs of discussion traffic between January 2010[34] and July 2016, with periods of above average conversation isolated and cross-referenced with an archive of forum posts to identify the primary driver(s) of the increase. Since each above-average peak in conversation traffic can include thousands of forum posts, random sampling is employed where appropriate to gather a statistically significant subset of the discussion in order to identify the primary drivers of the increase.[35]

4.2. External Economic Risks

Since it stands to reason that external economic risks would be the major driver for users to adopt Bitcoin as a risk-aversive activity – given that internal factors would only impact upon those individuals once they adopt the use of cryptocurrency – this discussion will begin with the analysis of those factors. Upon identifying these external factors within the raw data, three terms were identified – debt, inflation, and default – with their usage over time charted in Figure 4.1.

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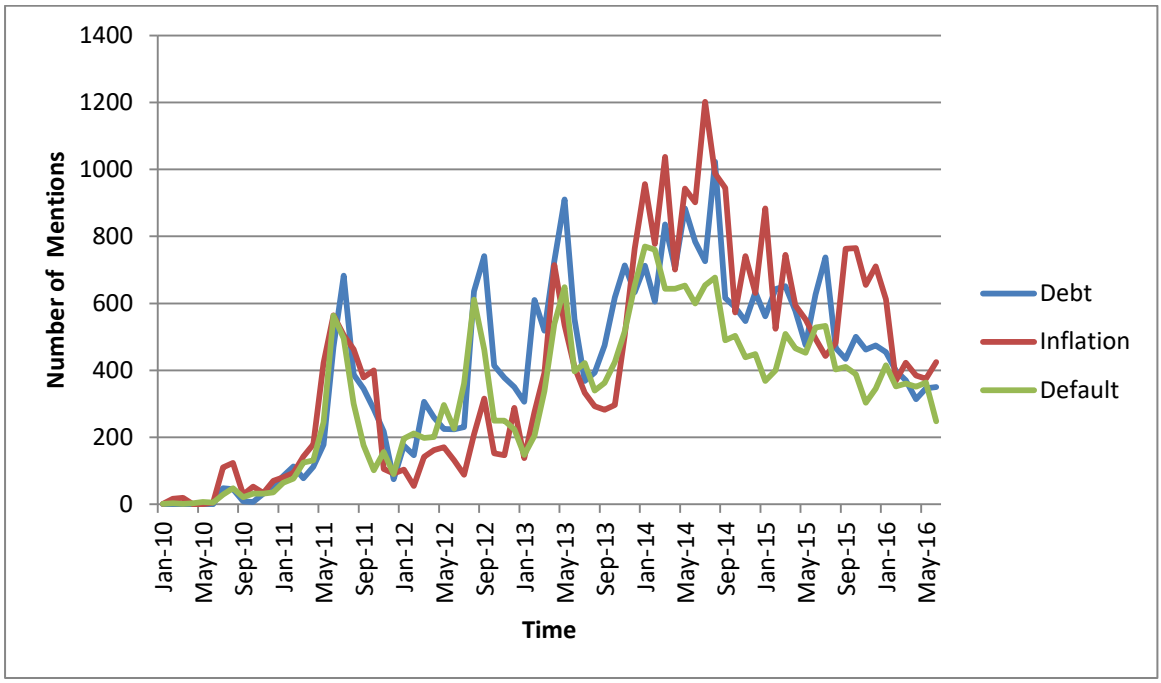
[32] For example, a "scam" that generates significant discussion could also involve instances of hacking, theft, fraud, and/or be a Ponzi scheme. Nevertheless, the definitions of each term are distinct enough to merit separate entries for analysis.

[33] While graphs are utilised throughout this chapter to provide a visual breakdown of the research findings, tables listing the number of each mention per month for each word can be found attached in Appendix B.

[34] With the exception of "security," which received two mentions on December 2009, and "default," which received four mentions in the same month, each word went unmentioned when the forum first went active in 2009. Given these statistically insignificant mentions, the graphs presented herein utilise the beginning of 2010 as their starting point.

[35] Although such analysis would have benefitted from time series data regarding the increasing membership on the forum, concerns about the accuracy of the source led this information to be excluded.

Figure 4.1: Frequency of discussion on external economic risk over time



Source: Author's construction using data derived from webscraping of Bitcointalk.org.

As shown in Figure 4.1, all three topics are prone to fluctuations over time, with an upwards trend leading into the middle of 2014 followed by an equally volatile downwards trajectory. A number of these peaks and troughs also occur over the same period, regardless of the word being used, suggesting a level of intersectionality between the discussion of each topic. This stands to reason, given that a default by its very nature requires a debt to renege upon; periods of high inflation can also be accompanied by high government debt (Reinhart and Rogoff, 2010); and states can, in a sense, default via inflation – with the real value of their repayments having declined, despite them having met the nominal value of their financial obligations (Aghion and Bolton, 2004). Nevertheless, these topics are distinct enough to merit individual analysis, beginning with "debt."

Discussions on debt have five periods of above average conversation traffic, including: May to July 2011; August to September 2012; January to May 2013; July 2013 to August 2014; April to July 2015. The first peak was driven by news that the United States was about to reach the borrowing limits

imposed by the debt ceiling, with House Republicans threatening to block raising it further. Although this drove speculation on what it might mean for Bitcoin if the United States subsequently defaulted on its debts, a compromise was reached and the ceiling was raised at the end of July, with discussion consequently dropping. The second peak was driven by internal rather than external risk, highlighting the occasional overlap between topics, with the extent of the Trendon Shavers Ponzi scheme[36] coming to light. During this period, Shavers closed down his operations and promised to pay back his debts, leading to confusion and concern about when and how this might eventuate. This matter was further compounded by another prominent Bitcoin figure, Matthew N. Wright, betting with other forum members that Shavers would repay his debts – only to renege on his own debts once Shavers disappeared without repaying his customers. Although these developments were met with widespread condemnation and outrage, the broad consensus amongst the Bitcoin community was that the majority of the user base consisted of trustworthy individuals – one of the last threads created at the end of the month titled "A suggestion to deal with bad BTC PR."

Whereas the first two peaks in discussion traffic regarding debt have singular, identifiable causes, the following three peaks appear to be driven by a higher than average number of news stories and events pertaining to debt. During the third and fourth peaks stretching from the first to third quarter of 2013, discussion traffic on debt was diffused across a number of topics, including: another standoff in the United States over raising the debt ceiling; the Cypriot banking crisis, which led to proposals of seizing the contents of savings accounts to repay the country's debts; Detroit becoming the largest US city to declare bankruptcy; and the US national debt topping $17 trillion. Conversation traffic was also driven internally by the growth of the Ripple payment protocol and exchange network, part of the second-generation of cryptocurrencies, which allowed for the transfer and

[36] The Trender Shavers Ponzi scheme was previously mentioned in the literature review, with more specific details provided under Footnote 5 of Chapter 3.

payment of Bitcoin and altcoins but only held its own XRP[37] as a digital asset, with all others being debt instruments/liabilities which exist in the form of balances (Vitalik, 2013). As such, this led to some early confusion as to whether the Bitcoin holdings of users on Ripple could really be said to exist or if there was some danger of losing them due to their status. Conversation traffic during the fifth peak was likewise driven by a number of topics, most predominantly: the US national debt topping $18 trillion; ongoing negotiations over the Greek debt crisis and the possibility of a default; and a collapse in the global price of gold. It should be noted that, regardless of the specific instance being referenced, discussion of national debt was predominantly defined by cynicism towards the policies of the relevant governments and/or central banks, with Bitcoin largely perceived as a hedge against these various external economic risks.

Discussion on inflation has similar levels of fluctuation compared to debt, although with its own distinct periods, with five peaks meriting analysis: May to June 2011; February to April 2013; October 2013 to July 2014, with a brief slump March and April 2014; October 2014 to January 2015; and August to September 2015. The first spike was driven by the realisation that although (or rather, because) Bitcoin was designed to resist inflationary pressures, its finite supply coupled with increasing demand left it prone to experiencing deflation. The increase in discussion traffic mostly coincided with the rise of message boards debating this issue, particularly in regard to whether a modest amount of inflation should be built into the system and whether or not deflation is actually a bad thing. Debate within the Bitcoin community largely paralleled that of academic literature on the subject, save for greater suspicion of inflation within the former group, with discussion traffic largely subsiding after it was argued that the ability to divide a single Bitcoin down eight decimal places and conduct trade with as little as 0.00000001 BTC provided a countervailing force (Bohr and Bashir,

[37] The cryptocurrency of the Ripple network is also known as the Ripple, although the units of currency themselves are rendered as XRP. At the time of writing, Ripple is the third-largest cryptocurrency behind Bitcoin and Ethereum, although its late emergence as part of the second-generation wave precluded it from further analysis.

2014). Commensurate with the findings of Ussing, et al. (2014), the second peak in conversation traffic was predominantly driven by discussion on inflation rates in Argentina and policies the socialist Kirchner government was putting in place to limit soaring inflation. In particular, critics pointed to the government imposing a ceiling on supermarket prices to combat inflation whilst continuing its policy of printing money and introducing larger denomination bills. The overwhelming consensus on this matter was that such inflationary policies were going to cause damage to the Argentine economy, with Bitcoin serving as a potential hedge against such an outcome.

The third spike over the period from October 2013 to July 2014 was driven almost entirely by the proliferation of, and increasing interest in, altcoin alternatives to the Bitcoin system. It must be noted that discussion on external inflationary events was also present across this period, with particular focus on Argentina, Venezuela, and European Union member states, although traffic on these topics was less frequent and followed similar lines to the previous peak. While a detailed analysis of discussion traffic on altcoins is provided further herein, the intersectionality between that topic and inflation largely revolved around different mining and production rates. One of the most common alterations to the Bitcoin model adapted by altcoin developers is to change the cap on the number of coins produced, the rewards distributed via mining, and the overall protection against inflationary or deflationary pressures. To borrow the examples given by Gandal and Halaburda (2014, p. 8), “The other cryptocurrencies… are very similar to Bitcoin and have been created by “forking the main Bitcoin protocol… Litecoin will generate 4 times as many coins (84 million)… Peercoin also does not have a limit on the total number of coins generated (although the number of coins generated at any time is known in advance).” The major driver of discussion traffic in this regard was whether or not these alterations provided a better alternative to Bitcoin, a subject that generated mixed opinions based upon personal preference and individual needs. The fourth and fifth spikes were driven, to a smaller extent, by further discussion on new altcoins although the primary cause of these upsurges in conversation traffic was the collapse in the price of gold and a

significant increase in the value of Bitcoin. A dedicated discussion on this subject is provided further herein, under the analysis of conversation traffic on gold and investment-related topics.

The level of discussion regarding default also has some overlap with the previous topics, with four identifiable peaks, followed by a gradual conversation decline punctuated with small upsurges. The four periods meriting analysis are: April to June 2011; June to August 2012; January 2013 to May 2013; and September 2013 to January 2014. The first peak in discussion was driven entirely by technical questions and discussions regarding the default settings of different types of software, rather than default of an economic nature.[38] The second peak was driven in its entirety by the collapse of the Trendon Shavers Ponzi scheme, a topic previously outlined during the analysis of "debt".[39] The third peak was predominantly driven by technical concerns related to the default settings of new software, as was the case in the first period analysed, although economic factors also contributed to a smaller extent: particularly, the debate over raising the US debt ceiling and the possibility of a default, the Cypriot banking crisis, and concern over how the Ripple system works – all topics elaborated on due to their intersectionality with the discussion peaks on debt. The final peak period from late 2013 to early 2014 was only driven by discussion traffic of economic default in the first two months, due to the showdown over raising the US debt ceiling. The possibility of the United States defaulting on its debts drove speculation on what such an occurrence would mean for Bitcoin prices, although this was ended by a compromise deal being finalised at the end of October. Discussion traffic in the remaining months was driven by concerns that high-profile members of the Bitcoin community were abusing their position on a trust rating system; an event outside the purview of this analysis.

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[38] Such technical concerns are present throughout each peak period, which is reflective of the webscraper software's inability to address homonyms. However, this topic does not solely drive above-average discussion traffic beyond this first peak.

[39] Naturally, the discussion of this topic was driven by many of the same posts outlined in the relevant peak of conversation traffic on debt, highlighting the intersectionality of the chosen factors.

4.3. Internal Economic Risks

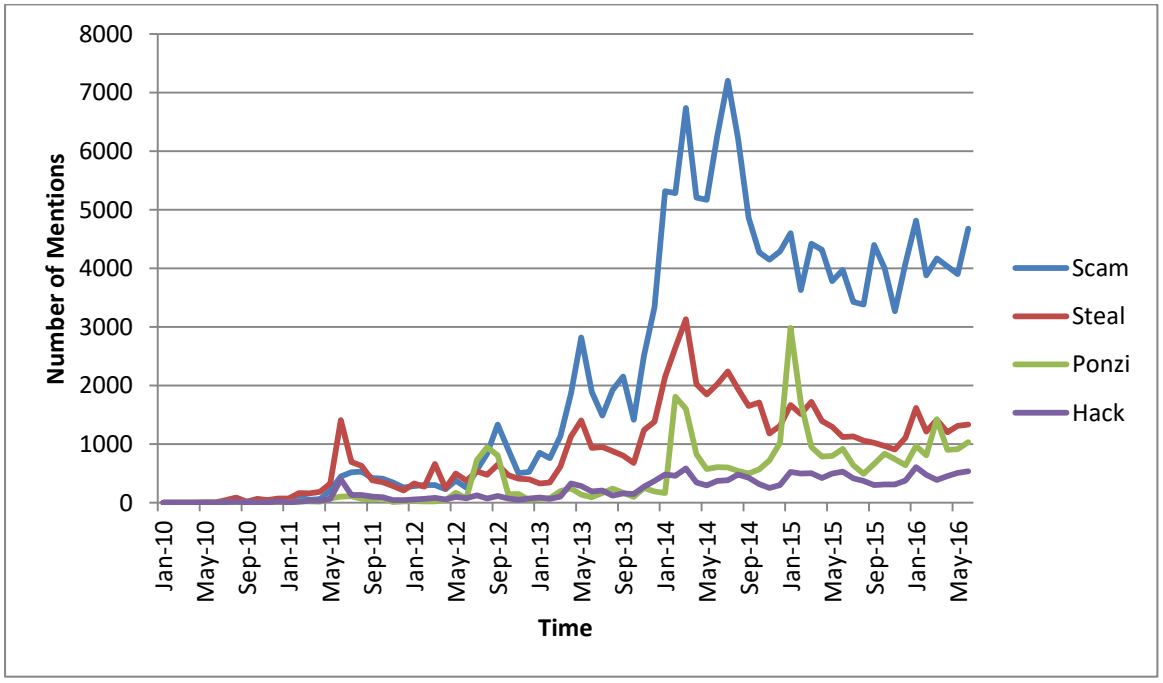
With the analysis of external economic risks thus defined, attention should be given to those concerns specifically related to the Bitcoin economy. Although these risks cannot shed light upon individual motivations for adopting Bitcoin, they nevertheless have an impact upon investment decisions once cryptocurrency is utilised within a portfolio. While Bitcoin may be utilised as a hedge against certain external economic risks, particularly the real or perceived failures of governments and central banks, it nevertheless carries with it its own internal vulnerabilities unique to the cryptocurrency market. This in turn highlights the fact that an investor cannot engage in hedging without carrying out some form of speculation. As such, it is imperative for this analysis to examine how these internal risks might impact upon the practice of hedging with respect to the use of cryptocurrency as a portfolio investment. In addressing internal economic risks, four topics of interest have been identified: scam, steal, Ponzi, and hack.[40] Whereas discussion of external economic risks reveals a degree of consistency over time, conversation traffic pertaining to internal economic risks as outlined in Figure 4.2 is much more volatile and episodic in nature, driven predominantly by major events in the Bitcoin marketplace.

The most frequently discussed internal risk is scams, which also outranked all other terms isolated during the course of the semantic analysis, with a conversation peak of over 7,000 mentions in a single month. Even after declining from this apex of discussion, scams remained a commonly featured topic within the Bitcoin community, with traffic fluctuating in a range between over 3,000 and under 5,000 mentions per month from late 2015 to the conclusion of this study in mid-2016. In addressing these fluctuations, four periods of above-average conversation traffic become identifiable: July to September 2012; March to May 2013; October 2013 to July 2014, with a brief slump in April 2014; and November 2015 to January 2016. The first peak in discussion was driven by

[40] While “volatility” was also identified as an internal economic risk, it will be addressed in the following section on investment-related activity due to the manner in which it impacts upon the topic.

the Trendon Shavers Ponzi scheme, a recurring subject due to its high level of intersectionality with other factors. The second peak in conversation traffic was driven by concerns that Butterfly Labs was engaged in deceptive business practices and fraud. This topic was also identified as a major driver of conversation in the semantic analysis of Teigland, et al. (2013), where they likewise determined that the consensus reached in April 2013 (in the middle of this peak) was that Butterfly Labs was selling a legitimate product.[41]

Figure 4.2: Frequency of discussion on internal economic risk over time



Source: Author's construction using data derived from webscraping of Bitcointalk.org.

The third peak, stretching from October 2013 all the way to July 2014, did not have a single driver of increased traffic, with discussions diffused across numerous topics that fell within three broad categories: a number of major and minor incidences of scams across this period; greater scrutiny by Bitcoin forum users seeking to determine the reliability of services; and growing community efforts to track and catalogue scams. The first category involved the conclusion of long-running

[41] As noted by Footnote 8 of the literature review chapter indicates, legal developments since this discussion period took place indicate that this may have been an incorrect assessment.

conversation topics, including Butterfly Labs which was closed down by the FTC (2014) due to complaints about fraudulent business practices, and the collapse of the Mt. Gox exchange. The second category represents the beginning of a trend which extends into the final peak discussed further herein, with growing caution amongst Bitcoin users in response to the previous incidences of fraud during the cryptocurrency's earlier years. Finally, the third category marks the continuation of a trend identified by Teigland, et al. (2013), with the rise of voluntary community watchdogs in the absence of a centralised authority.

The final peak does not seem to have been driven by any particular incident, with discussion traffic diffused across dozens of boards each dedicated to unrelated services. Despite the different products and service providers being discussed, threads related to scamming typically tended to fall within three categories: those identifying a service as a scam; those arguing that a service seems like a scam; and those related to potential users soliciting advice on the trustworthiness of a service before committing to its use. This change demonstrates a growing level of caution and individual responsibility amongst the Bitcoin user base in light of the number of high-profile scams experienced in the cryptocurrency's earliest years. Such a transition is commensurate with the observations made by Teigland, et al. (2013), who noted that community groups were collectively self-organising in the absence of central authority to counter these internal issues, and Tasca, et al. (2018), who have demonstrated a maturation of the Bitcoin economy towards more legitimate goods and services.

Discussions on stolen property, described herein as theft[42], were also a key area of internal economic concern over the life of the forum, with three peak periods meriting analysis: May to June

[42] While the word "theft" received some small mentions on the forum, the various incarnations of the word "steal" received a substantially higher frequency of mentions, hence their use in this analysis. As such, the use of the word "theft" herein should be interpreted as a grammatical choice, and not a reflection on the word usage employed in the forum itself.

2011; March to May 2013; and December 2013 to March 2014. Highlighting the intersectionality between the chosen terms, both the first and third spike were driven predominantly by the various incidences surrounding the collapse of Mt. Gox. In particular, the 2011 spike was driven by a hacker using the credentials of a compromised staff member to steal a number of Bitcoins, with further details of the incident provided further herein under the discussion of security, while the 2013 spike was driven by the last of the Bitcoinica hackings which led to the collapse of the exchange. The intersectionality between this topic and discussion traffic on theft was the belief amongst affected customers that Mt. Gox had been stealing funds, before it was determined that the losses were the result of a security breach by external actors. However, the second spike in early to mid-2013 was driven by discussions of external rather than internal economic risk: specifically, the Cypriot banking crisis. In particular, conversation traffic was driven by the belief that a proposal to impose a tax upon certain savings accounts to help alleviate the country's debt amounted to theft, with Bitcoin being proposed as a hedge against the state seizure of financial assets.

Ponzi schemes were another internal economic risk which generated period peaks in conversation traffic, with three identifiable above-average increases meriting analysis: June to July 2012; January to February 2013; and December 2014 to January 2015. The first spike was attributable to the collapse of the Bitcoin Savings and Trust Ponzi scheme administered by Trendon Shavers, which has been discussed throughout this analysis. This was to be expected, given the high level of intersectionality that this event had with the selected terms for analysis, as well as the fact that it remains the largest Ponzi scheme in Bitcoin history to date. Due to the intersectionality of topics, the second spike was also driven by a recurring topic: this time, Butterfly Labs and the concern that it might be a Ponzi scheme.[43] Discussion traffic on the final spike in late 2014 to early 2015 was

[43] As was the case in the semantic analysis by Teigland, et al. (2013), the conclusion at the end of this period of above-average conversation traffic was that Butterfly Labs was offering a legitimate product, although continued customer complaints and allegations of fraudulent transactions led to the service being temporarily shut down by the FTC (2014) a year later.

predominantly driven by two topics: the allegations that a Bitcoin mining service run by Joshua Garza called GAW Miners was a Ponzi scheme and increasing traffic through a new board titled "Cloudmining 101 (ponzi [sic] risk assessment)." In the former case, it was eventually discovered that Joshua Garza was defrauding investors in a mining scam and paying them with profits from his other ventures, such as a Bitcoin exchange called Paybase which collapsed later in April 2015 (Securities and Exchange Commission, 2015). The latter topic, however, which consequently drew additional traffic from the former issue, was a community watchdog dedicated to helping forum members identify Ponzi schemes from cloudmining sites, which the original poster argues usually conduct little Bitcoin mining themselves, and instead pay out old customers with the funds generated by new ones (Puppet, 2014). This thread offered advice on spotting Ponzi schemes, encouraged ordinary forum members to report suspicious activity, and conducted risk assessments of service providers with what data was available. At the time of writing, this thread claims to have an overall 95% rate in identifying Ponzi schemes; of these, 14 out of 14 recently imploded cloudmining scams were rated as very suspicious or Ponzi schemes, while only 1 of 7 companies rated legitimate or probably legitimate ended up substantially failing to honour their contracts (Puppet, 2014). This is consistent with the findings of Teigland, et al. (2013), which noted the rise of community watchdogs to counter illicit activities in the absence of a central administrative authority.

Despite being the subject of high-profile media attention both within and without the Bitcoin community, the term "hack" received minimal discussion traffic, although this may be reflective of the level of intersectionality between the selected terms as opposed to a deficiency of interest amongst the forum user base. Although discussion traffic on hacking tends to occupy a rather consistent range, four minor upticks were selected to provide a sample of conversation drivers: May to June 2011; February to April 2013; October 2013 to February 2014; and November 2015 to January 2016. As was to be expected by the degree of intersectionality between hacking and other selected terms, the 2011 spike was driven by the first hacking of Mt. Gox via a compromised staff

member's e-mails, which has been discussed elsewhere in this analysis. However, the later peaks in conversation traffic were driven by small incidences which failed to register across the other topics due to higher volumes of discussion elsewhere. The second peak was driven by the hacking of Instawallet, a Bitcoin wallet provider, resulting in the theft of over USD$129 million worth of Bitcoins and the service having to suspend its operations. This incident was largely attributed to poor security on the part of Instawallet, with it having been the target of a number of thefts due to its vulnerabilities. The third peak, from late 2013 to early 2014, was driven by the hacking of Inputs.io, another Bitcoin wallet provider, run by the parent company TradeFortress. The hacking resulted in the theft of over USD$1.2 million worth of Bitcoins, sparking concerns that other services under the TradeFortress umbrella, such as CoinLenders, were also potentially vulnerable. The final peak in conversation traffic, however, was not sparked by an incident of internal economic risk but rather the growth of services offering protection against it.

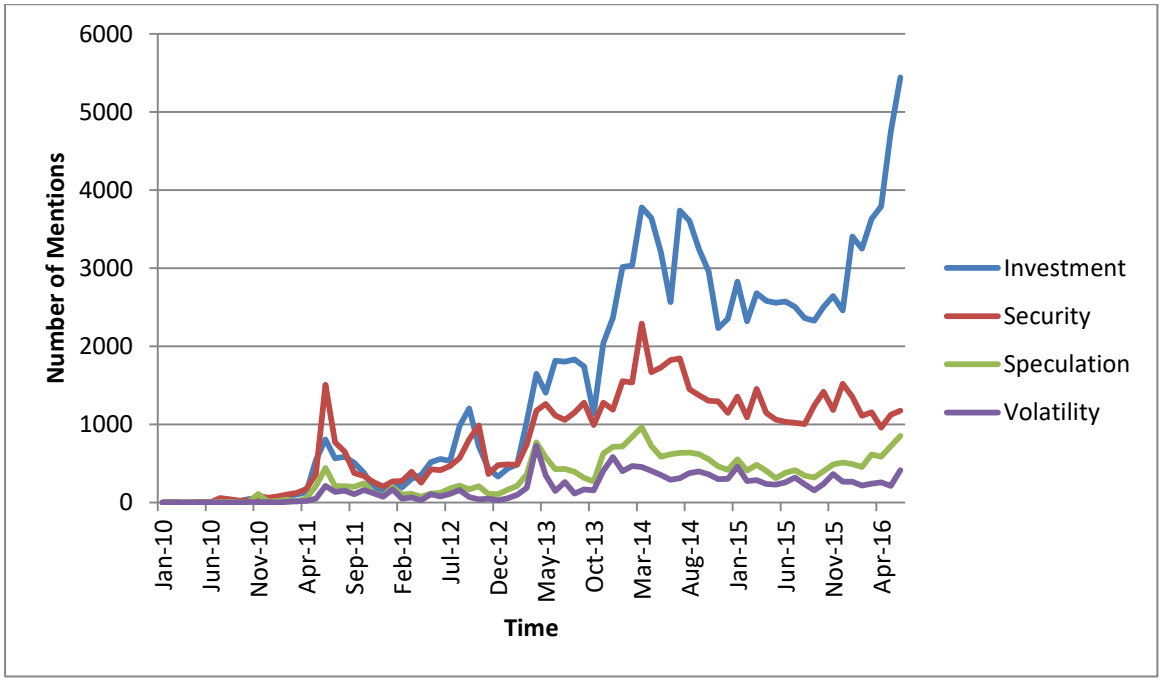
Discussion traffic was diffused across a number of threads dedicated towards offering to attempt to hack certain systems or requesting a hacker to do so in order to identify and fix flaws in digital security. One user with the screen name of looter (2015) even offered a $3,000 prize to anyone who could hack their Bitcoin wallet after losing their password: a request met with a considerable degree of bemusement amongst the posters. This growing aversion to internal risks and the development of means to effectively combat them is consistent with the findings of Teigland, et al. (2013) about the rise of institutional entrepreneurship, as well as the contention of Tasca, et al. (2018) that the Bitcoin is entering a "third stage" of its development defined by growing legitimacy of the market.

4.4. Investment-Related Discussion Topics

While an analysis of the forms of economic risk most concerning to Bitcoin users is important in addressing the research questions, a focus on investment-related discussion topics is also pertinent. Examination of the raw discussion data reveals two broad themes which merit attention: firstly,

generic terms which discuss investment practices more broadly; and secondly, specific terms related to particular investment options. While the latter topic will be addressed later in this analysis, the identifiable generic terms include investment, security, and speculation. Volatility has also been included in this section, despite being an internal economic risk, due to the impact which it has on investment-related activities, especially in regard to speculation. The conversation traffic of each topic is outlined below in Figure 4.3.

Figure 4.3: Frequency of discussion on forms of investment-related activity over time



Source: Author's construction using data derived from webscraping of Bitcointalk.org.

An analysis of the conversation traffic reveals that investment has become a topic of increasing interest within the Bitcoin community, with security also a prominent feature of discussion before entering a downward trajectory following its apex in mid-2014. This stands in contrast to discussions regarding speculation and volatility, which, despite being identified as major drivers of Bitcoin's value by the academic literature, nevertheless failed to generate significant discussion traffic.

Beginning the analysis with discussions on investment, five major upsurges in conversation traffic are identifiable: May to July 2011; July to September 2012; January to June 2013; September 2013 to July 2014, with a brief decline between March and June 2014; and December 2015 to June 2016. The first spike was driven entirely by an increasing level of interest in Bitcoin mining pools, with a particular emphasis on discussing which pools provide the best return on investment. Mining pools, quite simply, involve a number of individuals combining their computing power to solve the algorithms necessary for contributing to the blockchain and generating new Bitcoins, with those produced shared based on each members contributions. Although this reduces the total number of Bitcoins an individual might receive from making an addition to the blockchain, the increased computing power makes such contributions more frequent, making mining pools a popular investment particularly amongst those without high-end hardware (Lewenberg, Bachrach, Sompolinsky, Zohar, and Rosenschein, 2015). The second spike was also driven by the comparison of Bitcoin mining pools, although other contributors to the spike were a wider array of investment opportunities, including loans for long-term Bitcoin-related infrastructure or short-term speculation. Another driver of discussion traffic during this period was the collapse of Bitcoin Savings and Trust, the Ponzi scheme administered by Trendon Shavers that has been mentioned frequently throughout this analysis, although this period was prior to the full extent of his fraud becoming public with conversation primarily regarding whether or not he will repay his debts. The third peak was likewise driven by these topics, with the exception of the latter, with continued focus on Bitcoin mining pools, discussion of investment strategies and opportunities, and solicitations from small-scale investment funds.

While these trends were present throughout the fourth peak period, the marked increase in discussion traffic was driven by a number of topics with a clear mark of delineation between 2013 and 2014. The rise in discussion traffic during the 2013 period was predominantly driven by increasing investment opportunities during this period, including interest from mainstream financial

actors. In particular, two major ventures became topics of interest: the Bitcoin Investment Trust (BIT) and the Winklevoss Bitcoin Trust (WBT). The BIT (2017) was formed with start-up capital generated via the crowdsourcing platform, SecondMarket, and claims that its "shares are the first publicly quoted securities solely invested in and deriving value from the price of Bitcoin. The BIT enables investors to gain exposure to the price movement of Bitcoin through a traditional investment vehicle, without the challenges of buying, storing, and safekeeping Bitcoins." The WBT, founded by the billionaire Winklevoss twins, was the first Bitcoin exchange-traded fund to be filed with the SEC, with each share representing a number of Bitcoins held by the Trust. Naturally, discussions about this topic largely focused on the opportunities these organisations presented, the merits of investment in each, and the implications for the Bitcoin economy more generally. However, by 2014 the largest driver of conversation traffic shifted towards the rise in the number of altcoins available, with a renewed focus on mining pools and investment opportunities for Bitcoin's cryptocurrency competitors. Although a dedicated section on altcoins is provided further herein, it should be noted that interest in altcoin mining as an investment strategy was largely driven by the increasing difficulty of producing Bitcoins – a deliberate design feature implemented by Nakamoto (2008). As such, mining altcoins was seen as a way of increasing returns by exploiting arbitrage opportunities in the exchange rates, which is consistent with the findings of Hayes (2015). The final peak across the early to mid-2016 period was not driven by any single topic, with conversation traffic diffused across dozens of boards dedicated to different investment opportunities. Frequent investment-related discussions included, but were not limited to, solicitations for advice, advertising by private companies seeking investors, the increasing availability of Bitcoin gambling service, Bitcoin and altcoin mining pools, price predictions for those seeking to hold their Bitcoins over a long-term period, infrastructure services such as wallets and exchanges, and comparisons between alternative investments such as gold. This growing diversity of topics, as well as the increasing number of opportunities for Bitcoin investors, highlights the maturation of the cryptocurrency

economy identified by Tasca, et al. (2018), as well as a longer-term focus amongst members of the internal community.

Discussion of security had four identifiable peaks, two large and two slightly higher than average, including: May to June 2011; July to October 2012; January to April 2013; and November 2013 to March 2014. An analysis of these spikes in conversation traffic reveals that each was driven by concerns over internal economic risk, particular with regards to high-profile instances of hacking and fraud. The first peak was driven by a security breach at the Mt. Gox exchange, when a hacker used credentials from a compromised staff member's computer to transfer a number of Bitcoins to themselves. This was accomplished by selling them all on the exchange at once to flood the market, producing a massive ask order that caused the price of a single Bitcoin to drop to one cent. Although the price corrected itself within minutes, the incident nonetheless sparked concerns about the level of security at the Mt. Gox exchange. The second peak was driven by the Bitcoinica series of hackings, during which the eponymous Bitcoin trading platform suffered three different thefts as a result of vulnerabilities in its security being exploited. The Bitcoinica hackings have been mentioned frequently throughout this analysis, with conversation traffic pertaining to security following similar lines to the intersecting factors previously referenced. The third spike was likewise driven predominantly by an aforementioned security breach, this time the Instawallet hacking that resulted in the theft of more than USD$129 million worth of Bitcoins. As was the case during the analysis of discussion traffic on theft, conversation predominantly focused on and attributed the theft to poor security on the part of the Bitcoin wallet provider. The final peak, however, represents a marked shift in discussion topics with Bitcoin users finding proactive means of ensuring the security of their holdings and investments. The increase in conversation traffic during this period was defined by greater consumer scrutiny of services, with threads dedicated to requests for information on a product's level of security, community watchdog groups which provide ratings of services and their levels of protection, and security software firms seeking start-up capital from investors. This is

consistent with the findings of Teigland, et al. (2013), which noted that Bitcoin users were collectively self-organising to ensure better security in the absence of regulatory intervention, as well as a broader trend identified across multiple factors in this semantic analysis whereby the later period of the forum is defined by higher levels of caution and risk-aversion.

Despite being identified as major drivers of investment activity and a limitation to Bitcoin's growth potential, discussion traffic on speculation and volatility never surpassed 1,000 mentions in a single month period. Nevertheless, there are some periods of higher than average traffic which merit analysis, with speculation having four peaks: April to June 2011; January to April 2013; November 2013 to February 2014; and January to June 2016. The overwhelming driver of discussion traffic during the first peak period was a single message board titled "Bitcoin Forecast, Bitcoin Speculation & Bitcoin Technical Analysis. Up or DOWN?" This thread is a voluntary community group dedicated to providing forecasts on predicted future Bitcoin prices, in order to assist those engaging in speculation or longer-term investments, similar to the security-oriented volunteer groups identified by Teigland, et al. (2013). The thread is present throughout all peak periods, although it ceases to become responsible for any identifiable increases in discussion traffic after this point, with other subjects becoming more prevalent. The second and third peaks were driven by increasing volatility in Bitcoin prices, which members of the user base attributed to the influence of speculative investors. Opinion over this issue was divided across both periods, with many defending speculation as a legitimate practice with making a profit a desirable outcome, while others worried that Bitcoin's volatility would undermine its viability and credibility over the long term. However, no consensus appeared to be reached in either instance, with opinions seemingly dependent upon individual user preferences and investment choices. The final peak during the early to mid-2016 period, however, saw minimal discussion traffic dedicated to speculating on Bitcoin, with the increase driven by the proliferation of threads focused on altcoin mining speculation. Although discussion was diffused across multiple boards each dedicated to a different altcoin, with none emerging as dominant, the

topic was the same across each: short-term investors seeking to derive a profit by mining altcoins and exploiting arbitrage opportunities in the exchange rate with Bitcoin. This is reflective of both the argument on altcoin price formations put forth by Hayes (2015) and the increasing level of stability in Bitcoin's own valuation, at least relative to the earlier periods of its existence (Tasca, et al., 2018). More pertinent to this analysis, it suggests a potential decline in speculation relative to longer-term investments, a notion which will be elaborated upon further in the concluding remarks.

Although an internal economic risk, the impact of price volatility in investment-related decision-making (particularly with regards to speculation) led to its inclusion in this section of the analysis, with three peaks meriting analysis; March to April 2013; October to November 2014; and May to June 2016. As was to be expected, discussion traffic on volatility is primarily driven by periods of fluctuation in Bitcoin's value, although the low levels of conversation on the topic in general made it difficult to determine the driver of peak periods. The first peak in discussion traffic on volatility coincided with the second peak for speculation, with the driver appearing to be the same: a period of Bitcoin price volatility which the forum members attributed to speculative investment. While this generated the aforementioned debate regarding the possibility of speculation being harmful to long-term viability, community attitudes – at least insofar as they intersect with discussion traffic on volatility – had changed by the second peak identified, with another period of price fluctuations attributed to the natural tendencies of the business cycle. It must be noted that this period of price volatility coincided with a noteworthy drop in the price of gold, a topic which will be discussed under the relevant section further herein. It was not possible to determine the driver of the final peak in conversation traffic, with an analysis of the forum titles and posts revealing that there were no topics that received more attention relative to the others.[44]

[44] While this period in mid-2016 appeared to be showing signs of price volatility in light of global mainstream market uncertainty, the end of the data collection phase occurred in the middle of this peak, perhaps resulting in the loss of further clarifying information. However, it must be noted that because discussion traffic on

Given that levels of interest in long-term investments amongst the Bitcoin user base increased over the duration of this analysis, it is pertinent to also address some alternative portfolio options under discussion, most notably gold and altcoins. Along with discussions on "altcoins" in general, specific mentions of Ethereum were also extracted for analysis, given that this research will address their relationship to indices of economic confidence alongside Bitcoin in the following chapter.[45] Additionally, although Litecoin, Dogecoin, and Peercoin will not be employed in next chapter's analysis, information on each of these altcoins were extracted for analysis due to the fact they each feature prominently within the literature, marking them as potentially useful bellwethers for the analysis of altcoin trends (Gandal and Halaburda, 2014; Hayes, 2015). As outlined below in Figure 4.4, while discussion of gold and the generic term altcoins featured relatively consistent discussion, specific types of altcoin received a brief period of high conversation traffic before witnessing a decline, with the exception of Ethereum which was experiencing its growth during the period in which data collection came to an end.

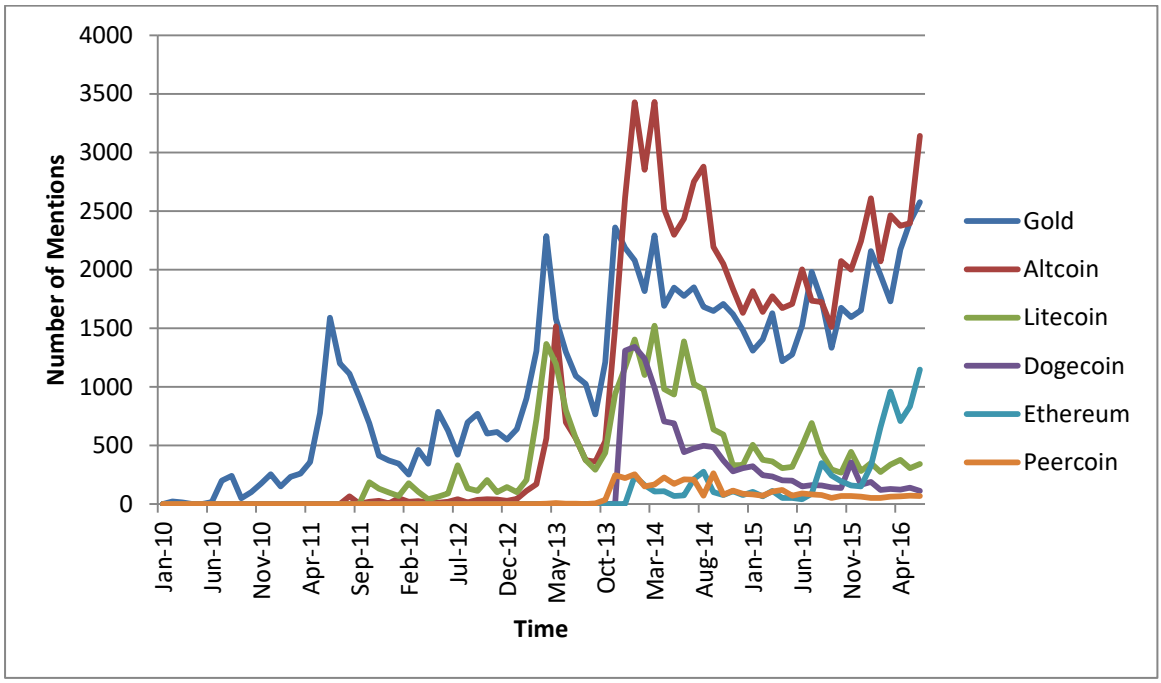
As outlined in Figure 4.4, gold is the most frequently discussed alternative investment on the Bitcoin forum, despite conversation traffic being overtaken by altcoins by late 2014. This suggests that users might also share an interest in the more traditional, tangible investment. Nevertheless, discussions regarding gold are prone to fluctuations over time, with four periods of above average traffic meriting further analysis: early to mid-2011; early to mid-2013; late 2013; and early to mid-2016. Examination of the archived forum posts reveals that gold is viewed positively as an investment and

volatility tended to be low in general, it is possible that a small scale increase over a one-month period is a mere coincidence within the acceptable margin of error.

[45] Although a number of altcoins scored above the threshold for inclusion in the semantic analysis, cursory examination of the raw data suggested that they followed a similar trend to those depicted in Figure 4.4, with the main period of discussion after their introduction followed by a gradual decline in interest over time. Given these similar trends, it was deemed appropriate to focus exclusively on the more prominent altcoins in order to avoid unnecessary clutter.

hedge within the Bitcoin community, with comparisons both positive and negative between them being quite common.[46]

Figure 4.4: Frequency of discussion on alternative investments over time



Source: Author's construction using data derived from webscraping of Bitcointalk.org.

The first spike in traffic, from May to July 2011, was primarily driven by a combination of three factors; firstly, concerns that Nanaimo Gold, a company which facilitates the buying and selling of cryptocurrency using a number of different payment methods, was engaged in "shady" business practices[47]; the ongoing United States Presidential campaign of Ron Paul, a Republican Congressman whose platform included a return to the gold standard; and a period of volatility in Bitcoin prices, leading some to propose backing the cryptocurrency with gold to provide a stabilising influence.

[46] Discussion of and support for the gold standard is also common throughout, although these topics are part of the average traffic throughout the course of the forum and not a driver of any identifiable periods of increased interest.

[47] These concerns were proven to be unfounded and Nanaimo Gold is still operating at the time of writing.

While the latter proposal was never adopted[48], it nevertheless generated considerable discussion, further highlighting the wariness with which price volatility is regarded in the Bitcoin community, despite it being an important factor for cryptocurrency speculators.

Analysis of the second and third spikes, which occurred with only a short period of declining conversation separating them, appear to have been driven almost entirely by the collapse of the price of gold during this period and the opportunities for investment it provided. In particular, Bitcoin achieved two major milestones with reference to the decline of gold prices: with the value of gold going down, Bitcoin reached an all-time high in its exchange price with the precious metal; and secondly, the price of Bitcoin achieved parity with the price of silver for the first time. One of the largest drivers of discussing across the mid to late-2013 period was a dedicated message board titled "Gold collapsing. Bitcoin UP," which alone accounted for upwards of 200 posts per month at the start of each peak and between 300 and 400 during the mid-to-apex periods. Naturally, discussion during this period was highly optimistic, with some hoping that the price of Bitcoin would reach parity with an ounce of gold in the mid to long-term. However, a comparison of conversation traffic with Bitcoin price data over this period reveals a distinct corollary relationship: in April of 2013, the value of Bitcoin grew 5-10% on a daily basis, with the peak in conversation coinciding with the top of a price rally at USD$266 per Bitcoin (CoinMarketCap, 2020). This was followed by a price collapse from May to November 2013, along with a considerable decline in conversation traffic, before another rally in the November to December period – where the price of Bitcoin exceeded the USD$1,000 threshold – brought about the third peak in discussion on gold (CoinMarketCap, 2020). These findings suggest that the level of interest in gold within the Bitcoin community is highly dependent upon the value of their cryptocurrency holdings, with analysis of the fourth and final spike supporting this conclusion: during another price rally over the May to June period where the

[48] Although a number of altcoins purport to be backed by gold, they simply allow users to exchange their cryptocurrency for its current market value in gold, as opposed to each serving the function of a "promissory note" as would be the case under a true gold standard.

price of Bitcoin jumped from USD$450 to USD$750, the largest drivers of conversation traffic on the forum where the message boards titled “Bitcoin or Gold? What would you pick?” “Is Bitcoin Becoming More Stable Than Gold?” “Bitcoin or gold?” “Holdings of gold vs Holdings of btc,” and “Is gold better than Bitcoin?” This demonstrates the overlap in desired functions between the two investments amongst the Bitcoin community, particular in regard to their hedging properties, despite Dyhrberg’s (2015) suggestion that, unlike gold, Bitcoin resides between the pure store of value or pure medium of exchange function.

Much like gold, discussion on “altcoins” in the general sense has shown a consistent growth in interest over time, despite periodic fluctuations in conversation traffic. In particular, four noteworthy spikes merit further analysis: March to May 2013; November 2013 to January 2014; September 2015 to January 2016; and May to June 2016. Naturally, the first peak was characterised by increasing interest amongst the Bitcoin user base about the new wave of altcoin competitors to enter the market, with three primary drivers of conversation: threads announcing the launch of various altcoins during this period; technical questions about recommended software related to altcoins, including mining and exchanges[49]; and programmers seeking advice on how to create altcoins of their own design. This suggests an interest amongst the Bitcoin user base for an alternative product, whether to satisfy a niche demand or to replace their Bitcoin use entirely, although the cryptocurrency’s continued dominance of market share highlights the difficulties in accomplishing this (CoinMarketCap, 2020). The second peak was likewise characterised by a renewed interest in altcoins, this time driven by concerns regarding the uncertainty and volatility of

[49] Technical questions of a similar nature were three of the eight major topics identified by Teigland, et al. (2013) during their own semantic analysis, albeit with specific reference to Bitcoin. This is most likely attributable to the technological as well as economic nature of cryptocurrencies, which requires a basic understanding of the software involved prior to adoption. This trend was replicated in the early peaks for each specific altcoin analysed further within this section.

Bitcoin's price.[50] Although this generated discussion about alternative investments, such as altcoins, no single cryptocurrency competitor dominated discussion during this period. Instead, conversation traffic was diffused across several dozen message boards each dedicated to a different altcoin, further demonstrating the high level of competition in the cryptocurrency market and the corresponding difficulties in a challenger to Bitcoin's market dominance emerging.

Attempting to determine the primary drivers of the third and fourth peak discussion periods was more complicated, as conversation was likewise diffused across multiple boards with mid-level activity, although none were related to discussion of particular altcoins. Instead, dozens of threads were soliciting advice on altcoins in general, with regards to which Bitcoin competitors had the best investment opportunity. Analysis of forum posts in the late 2015 to early 2016 period revealed that users were planning their investments in advance of the New Year, seeking out altcoins with the best growth prospects in coming months. While this New Year incentive to revise investment portfolios was absent by the time of the mid-2016 peak, the discussion topics were nonetheless driven by the same focus on investment and requests for advice from members of the broader Bitcoin community. As such, discussion on altcoins within the Bitcoin community can be defined by two identifiable periods: the first, in the earliest two-thirds of Bitcoin's lifespan, was driven by interest in and anticipation of a cryptocurrency alternative which would replace or compete with Bitcoin on roughly even terms; the second period, in the later third of Bitcoin's existence, has witness a maturation of the cryptocurrency investment market, with mid to long-term analysis of investment opportunities dominating in lieu of discussions on the latest altcoin to enter the market. This is reminiscent of the argument put forth by Tasca, et al. (2018) that Bitcoin is currently in the third phase of its evolution, which is defined by more legitimate business practices and longer-term decision making.

[50] These fluctuations in Bitcoin prices were the same that resulted in increased discussion of gold during this period, with the relevant details outlined in that section above.

Despite the identifiable trend of increased interest in altcoins over time, an analysis of specific altcoins highlights the difficulty such cryptocurrencies face in emerging as an alternative to Bitcoin. With the exception of Litecoin, which will be discussed further herein, the targeted cryptocurrencies each experienced a single period of high conversation traffic followed by a gradual or sudden drop-off. Ethereum was in the midst of its surge when the data was compiled, thus making it uncertain whether or not it will follow a similar trajectory. Analysis of the archived forum posts discussing each cryptocurrency reveals that these peaks are commensurate with the launch date of each altcoin, where online community interest is at its highest. The first peak in Litecoin discussion, and the sole peaks for Dogecoin, Peercoin, and Ethereum occurred in the lead up to and aftermath of them going online for trading on the market. Each altcoin message board shared the same predominant topics: requests for technical advice on mining, payment transfer, and other relevant software; comparisons of the pros, cons, and different features of each altcoin relative to Bitcoin; and predictions for each altcoin's future potential.

The subsequent decline in discussion that follows occurs when the altcoin is no longer new, with potential users having made up their mind whether or not to adopt it, and its viability now known rather than purely theoretical. This latter issue is further compounded by the fierce competition in the cryptocurrency market and Bitcoin's dominance of the market share. As such, the discussion base for each period consists of two very different demographics: in the early post-launch period, discussion is driven not just by those who have chosen to adopt the altcoin in question, but also potential users, those simply curious, and others drawn in by the increased attention; in the mid-to-long term, the discussion base dwindles down to actual users and people showing a late interest outside the peak early period.[51]

[51] This trend is commensurate with market research on the product life cycle more broadly, with the "buzz" generated by a new product launch leading to a take-off followed by a decline in sales during the following slowdown period (Golder and Tellis, 2004).

Whereas discussion of the other altcoins ended with a precipitous drop-off in conversation traffic, Litecoin experienced two other spikes from October 2012 to March 2013 and, to a lesser extent, from April to July 2015. Part of this success where other altcoins experienced a decline in interest may be attributable to Litecoin's smaller but persistent market share, with it being the fourth largest cryptocurrency overall and the second largest of the first-generation wave of altcoins (CoinMarketCap, 2020). This, in turn, suggests a degree of economic viability and/or useful technological features which allow it to stake out its own niche even in the absence of claiming market dominance. An analysis of posts during the second spike from late 2012 to early 2013 demonstrates much of the renewed interest stemmed from conversations regarding altcoin mining, with Litecoin's then-current exchange rate making it profitable to mine and then exploit the arbitrage price during exchange.

This finding is commensurate with the argument put forth by Hayes (2015), that while the value of Bitcoin tends to be defined in comparison with fiat currencies, the valuation of altcoins is driven by their arbitrage opportunities with Bitcoin. As such, interest in altcoins can be considered to at least in part be motivated by the desire to derive a profit via short-term investment opportunities in the mining sector. However, the third spike in mid-2015 comes in the wake of a price collapse in the Litecoin market (CoinMarketCap, 2020). Although this turn of events was topical enough to witness a spike in discussion traffic, the cryptocurrency market – and subsequently user portfolios – had undergone an evolution by that point, with many noting that their investment activities had moved beyond the stage they considered to be defined by Bitcoin/Litecoin competition and the peak of arbitrage opportunities between them. Incidentally, one commentator named Flanagan (2015) wrote during this period that they "didn't know litecoin was still kicking; I bought a very little amount many months ago and saw that the price has collpased [sic] so thought it would probably dissapear [sic] completely."

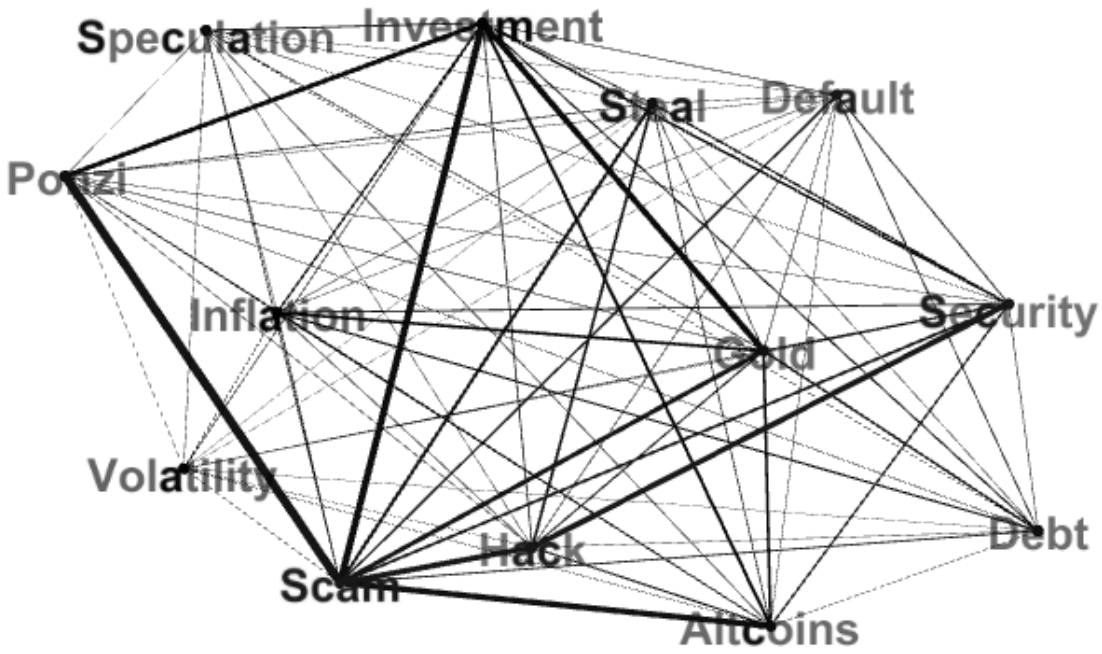
4.5. Semantic Network Analysis

Given the high level of intersectionality between topics of interest, it is pertinent to map out the conversational network in order to identify the relationship between terms. In order to accomplish this, this research will employ a semantic network analysis, a method of identifying the central factors within a data source and mapping out the relationships connecting them to one another (Doerfel, 1998). Each of the thirteen *n*-grams identified in Table 4.1 has been selected to serve as nodes within the network map, designating their role as topics of interest, with a series of edges connecting them to one another based on the strength of their social relationship. Each edge is weighted based upon the total number of forum posts which include both *n*-grams within the same message; for example, a single post that includes references to both "investment" and "altcoins" would fall within this category, with repeated iterations of this theme producing a thicker edge. Along with helping to further clarify the level of intersectionality between topics, a recurring theme in the semantic analysis, the construction of a network map serves an additional function. Whereas the semantic analysis focused solely on peak periods of above-average discussion traffic, owing to the sizeable volume of the data, the network map will incorporate every instance of two *n*-grams being used in conjunction during the weighting of edges to provide additional context. At this point, it should be noted that in order to ensure visual clarity in this graphic, the strength of the relationship between nodes is delineated by the thickness of the edge rather than its length. Furthermore, it should be noted that due to the number of *n*-grams employed in this analysis, the placement of nodes within the network map does not indicate anything significant; that is, the relationship between nodes is indicated by the edges connecting them as opposed to greater proximity on the network map.

In determining the relevant data contained within the semantic network, it is pertinent to note that the most meaningful relationships exist between the investment-related activities and forms of risk, as opposed to any intra-risk or intra-investment discussions. For example, the strongest relationship

in terms of social distance exists between the *n*-grams "hack" and "steal," which both constitute forms of internal economic risk and have a correspondingly high level of intersectionality. Indeed, as determined previously by this analysis, although the two terms are themselves distinct, instances of hacking within the cryptocurrency market are almost always tied to the theft of units of Bitcoin, hence the strong correlation between the two *n*-grams. As such, throughout the analysis of this semantic network, this research will focus upon the relationship between investment-related activities and forms of economic risk, both internal and external, rather than the relationships between *n*-grams which fall within the same category.

Figure 4.5: Map of the semantic network



Source: Author's representation based on semantic network analysis.

As the most commonly used investment-related *n*-gram, and the second most used term amongst those selected for inclusion in this research, analysis of the semantic network shall begin with measuring the social relationships connected to 'investment.' The *n*-grams possessing the strongest social relationships with 'investment' both fell within the category of internal economic risks:

namely, ‘Ponzi’ and ‘scam.’ The existence of a long social distance between these *n*-grams is both understandable and consistent with the high level of intersectionality between these topics identified throughout the semantic analysis. Indeed, the most high-profile instances of scams and Ponzi schemes to impact upon the Bitcoin market emerged repeatedly throughout the peaks in discussion traffic pertaining to investment-related activity: notably in instances such as the collapse of the Trendon Shavers Ponzi scheme (Teigland, et al., 2013). In this case, the lack of strong social relationships is as informative as the existence of them, with ‘investment’ possessing no meaningful edges linking it to *n*-grams regarding external economic risk. While instances of strong intra-category social relationships provide less pertinent information for the purpose of this analysis, it should nevertheless be noted that discussion on investment also maintains a considerable degree of intersectionality with ‘gold’ and ‘altcoins.’ This connection is only natural, given that these two *n*-grams denote specific forms of investment and would thus degree of intersectionality, but it also reinforces the findings of the semantic analysis indicating a high level of interest in these assets amongst the Bitcoin user base.

Although analysis of the overarching topic of ‘investment’ highlights the risk appreciation of Bitcoin users more broadly, a focus on specific instruments – chiefly, ‘gold’ and ‘altcoins’ – provides greater contextualisation of this information. As was perhaps to be expected, the *n*-grams which maintain the closest social relationship to gold almost all pertain to external forms of economic risk, owing to the fact that the commodity exists outside the cryptocurrency market and is thus insulated from the more technologically-based hazards which affect Bitcoin. In particular, gold maintained a long social distance with the *n*-gram ‘inflation,’ as well as smaller but still significant relationships with ‘debt’ and ‘default.’ The high volume of posts mentioning both ‘gold’ and ‘inflation’ in conjunction with one another is understandable, given that the asset has a long and well-established history of being used as a hedge against inflationary pressures by investors (Dempster and Artigas, 2010). However, the social relationship between gold and the *n*-grams debt and default are best understood within the

context of discussions pertaining to the gold standard, a secondary debate amongst the Bitcoin user base due to their interest in the precious metal.

Advocates of the gold standard believe that fiat currencies, which are not backed by any tangible commodity, are essentially worthless and derive their value solely from trust by their citizens, financial institutions, and foreign governments which hold their currencies as reserves (Hayek, 1990).[52] As such, this trust – and subsequently the value of a fiat currency – can evaporate in the event of state or market failures, such as a government defaulting on its debts. It should be noted that although debates regarding the merits of a gold standard were identified as a common topic of discussion during the semantic analysis portion of this research, they were not so prevalent as to drive conversation traffic during any peak periods. Despite the majority of its closest connections being with external forms of economic risk, gold also possesses a long social relationship with the *n*-gram 'scam.' The long social distance between these *n*-grams likewise extends from the frequent comparisons between gold and cryptocurrencies as identified in the semantic analysis. Although gold is generally thought of in positive terms by the Bitcoin user base, the debate over which of the two presents the superior form of investment remains a controversial topic. As such, the long social distance between these *n*-grams is best understood as an extension of that debate.

Naturally, the inverse of this trend is apparent in analysing the network connections of the altcoin node, with its strongest social relationships being between internal economic risks to the exclusion of external factors. The two most prominent relationships to fall within these categories are 'scam' and 'hack,' unsurprising given that these two internal economic risks have long plagued the cryptocurrency market and have emerged repeatedly throughout this analysis. Less prominent, but still statistically significant, social relationships connect the altcoin node to the *n*-grams 'Ponzi' and

[52] Naturally, the debate surrounding the merits of a currency standard falls well outside the purview of this analysis, with this brief and insufficient overview intended solely to provide clarification on the discussions individual Bitcoin users are having.

'security,' which likewise adhere to the same overarching theme. At this point, it should be noted that although security has been identified as an external economic risk throughout this analysis, the context in which it is used in regard to its social relationship with altcoins is internal in nature, referring to the security of the digital infrastructure.

As previously demonstrated, increased forum discussion traffic pertaining to altcoins – both the general term and specific cryptocurrencies – is primarily driven by a period of peak interest, during which its features, capabilities, investment potentials, and benefits are discussed and debated. Naturally, as Bitcoin users interested in alternative assets such as altcoins, comparisons between the former and the latter are common. This in turn serves to strengthen the social relationship identified in the relevant edges between the altcoin node, given that the vulnerabilities of Bitcoin and the potential of a given cryptocurrency to share or address those internal risks are central themes of these discussions.

Finally, attention should be paid to the *n*-gram 'speculation,' which the prior semantic analysis determined plays a small role in discussion on investment-related topics, despite being identified as a major driver of Bitcoin prices throughout the extant literature. Analysis of the map of the semantic network further reinforces this trend, with 'speculation' maintaining a relatively short social distance between all other terms, none of which rise to a noteworthy level of connection. Although this could serve to reinforce the overall research finding of this analysis that Bitcoin users have a greater focus on longer-term investments as opposed to short-term profit-making through speculation, it could also be indicative of a potential sampling bias. Individual users solely or predominantly interested in short-term profit-making are probably less likely to regards themselves as part of a broader "Bitcoin community," and thus would not be well-represented on the forum from which this data was compiled. However, given that this research finding contradicts the established corpus of literature, it could also serve to change the perception of the motivations and investment activities of the

Bitcoin user base, provided that additional supporting evidence can also be derived. Findings that are more detailed are set out in the survey analysis of Chapter 5.

4.6. Overview from the Findings

In illuminating these semantic analysis findings through the lens of the micro-meso-macro (MMM) framework, the role of the online Bitcoin community and its evolution over time becomes noteworthy. Based on the content of the analysed discussion data, the Bitcoin community appears to function as a means of dealing with the uncertainty inherent in a nascent marketplace through both the pooling of knowledge and the distribution of preferences. In particular, there are three trends worth considering. The first is on how the Bitcoin community collectively self-organises over time to deal with internal risks. The second trend observed is a greater volume of discussion on longer-term investments rather than short-term speculation. Finally, there is a greater volume of discussion on internal rather than external risks, with little discussion on the apparent difference in how the two are perceived.

Charting the evolution of the Bitcoin community across a meso trajectory, the online message boards emerged during the origination stage. In particular, first adopters at the micro level coalesced to collectively deal with the knowledge problem brought about by de-coordination (i.e. the transition away from mainstream markets and institutions towards the cryptocurrency market). This resulted in the emergence of community spaces at the macro level that served as a common pool of knowledge resources, in which information was curated and dispersed. This is evidenced by both the findings of this research, as well as Teigland, et al. (2013), both of which show that many of the earliest spikes in conversation traffic were driven by technological and practical issues that required input from more experienced users.

As the Bitcoin community evolves into the adoption phase of the meso trajectory, it becomes increasingly sophisticated. For instance, while problems were identified and discussed during the earliest spikes in discussion traffic, later spikes demonstrated a shift towards addressing these problems through collective self-organisation (e.g. community watchdogs and ratings agencies). The other two trends demonstrate different levels of discussion traffic between both long-term investments and short-term speculation, and internal risks and external risks. In both cases, the community was predominantly concerned with the future of Bitcoin in relation to long-term and internal issues. This is most likely indicative of the forums acting as a market for preferences, in which the perceived expertise of community members in areas that directly affect its development as a currency tool is responsible for the high level of discussion.

4.7. Summary

Despite the difficulties in deriving data from a significant sample of the pseudonymous and disparate Bitcoin community, this chapter has employed semantic analysis to analyse approximately 13.7 million posts from 862,298 users. Through such an approach, it was possible to analyse a considerable volume of data pertaining to the risk appreciation of Bitcoin users, their investment considerations, and the evolution of their community over time. Although the findings will not be discussed in-depth as they relate to the research questions until Chapter 7, owing to the interconnected nature of the empirical analyses, a number of trends merit attention. Firstly, there has been a notable evolution of the community over time, with individuals self-organising to combat risks. Secondly, despite speculation being regarded as a major driver of Bitcoin's price fluctuations, it features little in discussions relative to longer-term investment opportunities. Finally, discussion of internal risks tends to treat them as problems to be solved, while conversations pertaining to external risks conversely treat them as hazards to be avoided or mitigated. Nevertheless, these findings are representative of a passive approach observing Bitcoin users in a "natural" setting, with none of the benefits of an interactive exchange between the researcher and the research subject. As

such, to address further the research questions, this study uses these observations in a direct survey of Bitcoin users in the next chapter.

5. Survey Analysis

The results of the semantic analysis in the previous chapter are to be viewed as the first line of inquiry prior to construction of a survey that forms the basis of this empirical chapter. The survey approach allows for the collection of targeted interactive data, with the limitation being that the sample derived from a voluntary survey is necessarily smaller than passive monitoring of existing conversations. As such, the two approaches in conjunction complement one another, with the semantic analysis compensating for the limitations of the survey and vice versa. The survey is of Bitcoin users with respondents sourced from a number of online message boards and forums. Section 5.1 of the chapter defines the size of the survey sample and factors relevant to the analysis; sections 5.2 through 5.4 presents the results of the three-part survey, detailing respondent demographics, levels of trust and confidence, and short answer questions, respectively; section 5.5 consists of a cluster analysis of the sample and section 5.6 analyses the factors pertaining to cluster allocation; section 5.7 ties these findings to the MMM framework; and section 5.8 offers a summary.

5.1. Data Collection

The research in this chapter is underpinned by a three-part survey, with data collected from a trio of online cryptocurrency forums: bitcointalk.org, r/Bitcoin, and r/BTC. By the end of the data collection phase of this research, a total of 632 Bitcoin users provided information for the survey, with 294 completing all three sections and the remaining 338 returning partial responses at various stages of completion. Given this significant pool of incomplete responses that still had the potential to offer useful information, it was determined that these answers should be incorporated into the research, provided they reached a certain level of completion to merit their inclusion. A threshold was set for completion of the first two sections of the survey – user demographics and confidence/importance rankings – with any responses that fell short of this criteria deleted from the data pool. This process

reduced the number of respondents whose answers will be employed in this research to 382, with 294 complete and 88 partial responses. The margin of error is +/-5% for results utilising all respondents, and +/-6% for those employing only full completions of the survey. Despite the limited sample size, the results of the survey are not intended to be viewed in isolation and will be compared to the broader-based semantic analysis for points of overlap and divergence.

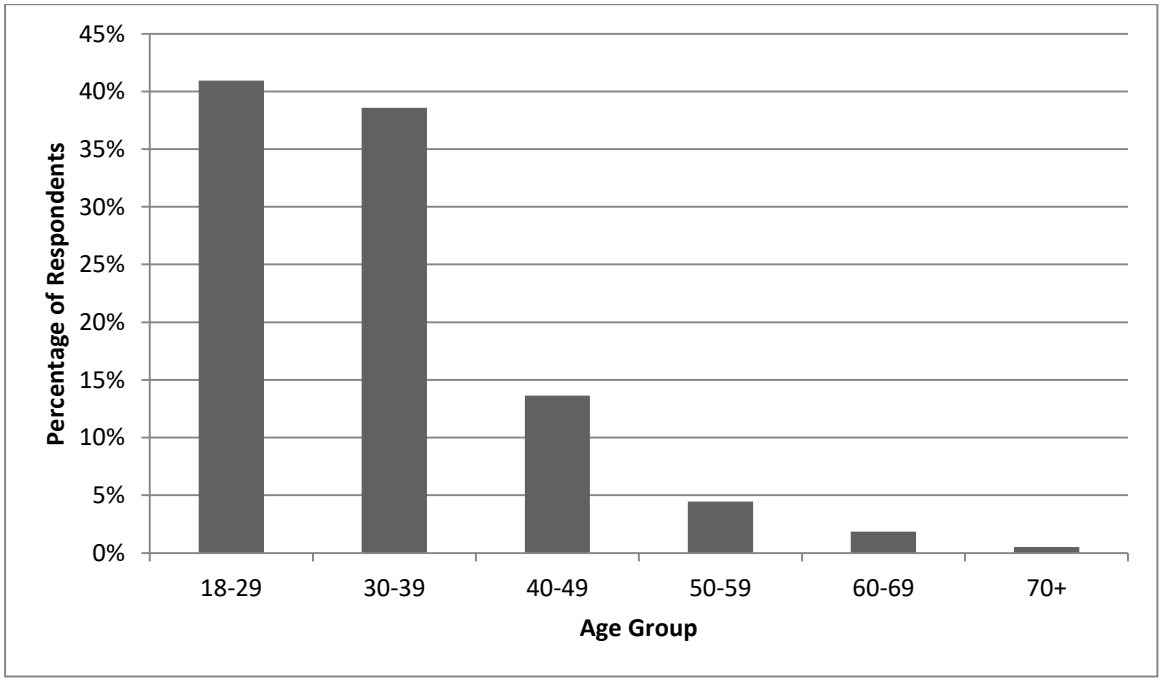
5.2. Demographics of Bitcoin Users

In order to ground the research findings derived from the later sections with background information on each of the respondents, the survey began by determining the demographic makeup of the sample. In particular, ten questions were posed to determine demographic factors including gender; age; country of residence; level of education; current occupation; political ideology; the year in which the user first started using Bitcoin; and the type of investment they believe best describes the manner in which they use cryptocurrency, selected from a number of options presented further herein. The respondent demographics on gender and age distribution offered the most expected results given the literature in this regards and their adherence to popular perceptions, with the survey pool being both male-dominated and youth-oriented (Smyth. 2013; 2014). In particular, an overwhelming 94.75% of respondents were male, while 40.94% were aged 18 to 29 and 38.58% were in the 30-39 age bracket, with each successive bracket comprising less of the survey pool than the last. Although the extent of male domination of the user base may appear indicative of a sampling bias, it is commensurate with previous studies of Smyth (2013; 2014), which found a similar supermajority of men represented in the user base with a larger sample of 1,000 users. As such, this analysis will operate under the assumption that the disparity is an accurate reflection of the Bitcoin user base.[53]

[53] Although the gender disparity represented within the user base is outside the scope of this analysis, the topic will be addressed further in section 8.3, which explores future avenues for research.

The age distribution of the survey sample, presented in Figure 5.1, is likewise skewed towards a younger demographic, with over 79% of respondents being under the age of 40. Once again, this disparity is likely an accurate reflection of the user base rather than the result of a sampling error, given that young people are more likely to accept and utilise emergent forms of technology than their older counterparts (Parasuraman, 2000; Hargittai and Hinnant, 2008). The age distribution of the survey sample is presented in Figure 5.1.

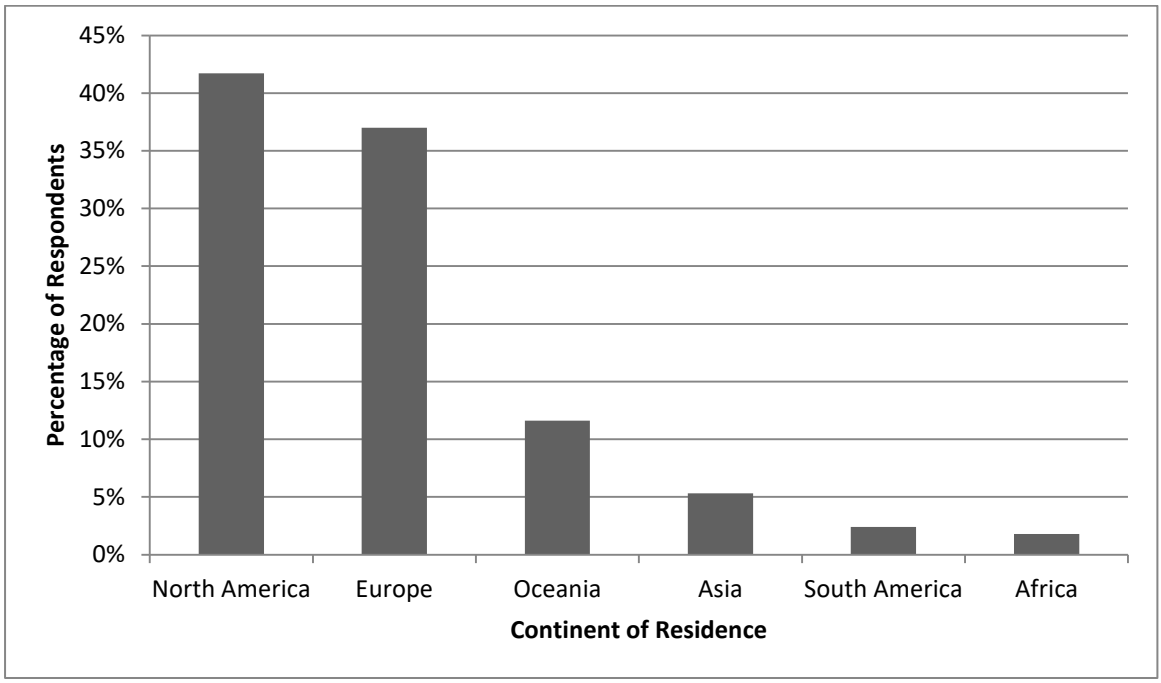
Figure 5.1: Age distribution of the survey sample



Source: Author's data derived from survey responses.

A higher level of diversity was reflected in countries of primary residence, with 58 different nations indicated by the survey pool. In the interest of concise presentation of the data, this preliminary analysis and the graph in Figure 5.2 addresses this demographic on a continental rather than national basis. A complete breakdown of respondent demographics by country can be found in Appendix C, and will also be featured in the later stages of analysis.

Figure 5.2: Continent of residence of the survey sample



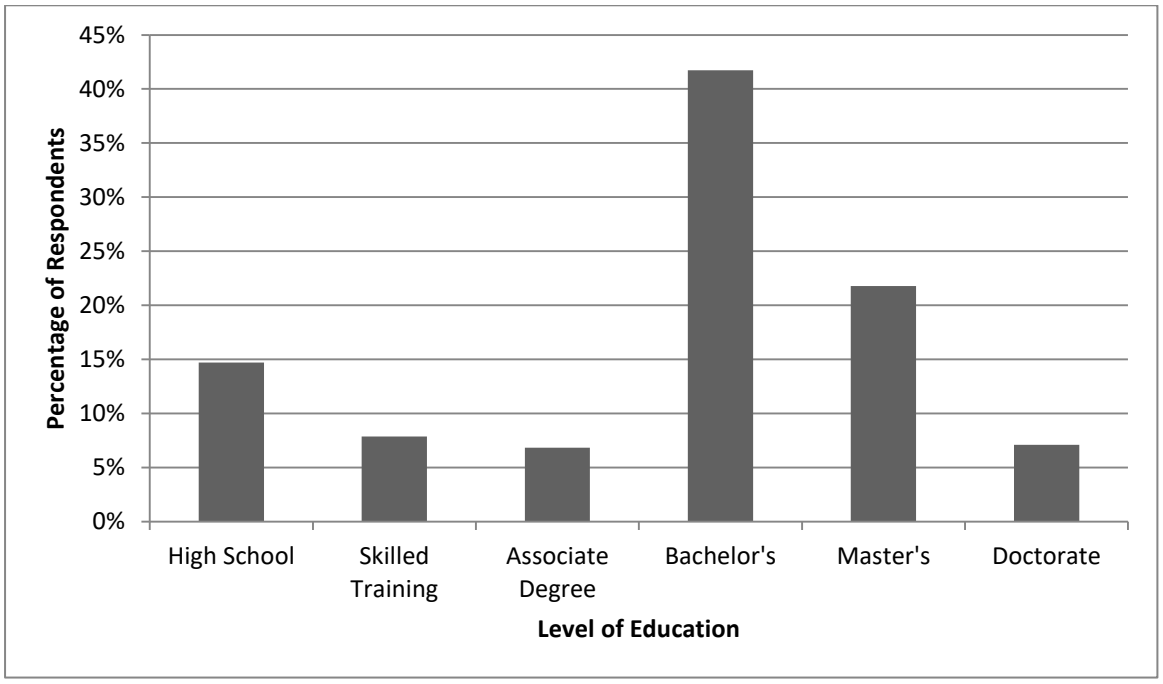
Source: Author's data derived from survey responses.

The data shows that 41.7% of respondents come from North America; 37% come from Europe; 11.6% come from the Oceania region; 5.3% come from Asia; 2.4% come from South America; and 1.8% come from Africa. Consequently, this means that more than 80% of respondents come from the developed Western world, although it must be acknowledged that such a figure may be representative of sampling bias inherent in the websites targeted for data collection. This potential sampling bias is pertinent given the research of Ussing, et al. (2014), which identified the popularity of Bitcoin in Latin American social democracies dealing with high inflation. However, the research by Darlington (2014) and Bouoiyour and Selmi (2015) has likewise indicated that Bitcoin has proven popular in the West amongst those with declining confidence in governments and/or central banks, suggesting that the high representation of these regions may be accurate.

The next set of questions in the survey queried respondents on their level of education and current field of employment. In order to avoid cluttering the data on the latter factor with responses

pertaining to similar fields, occupations were grouped together based on the level of education necessary to hold such a position; for example, unskilled, skilled certificate, or degree-based employment. The responses to these two questions are displayed in Figures 5.3 and 5.4.

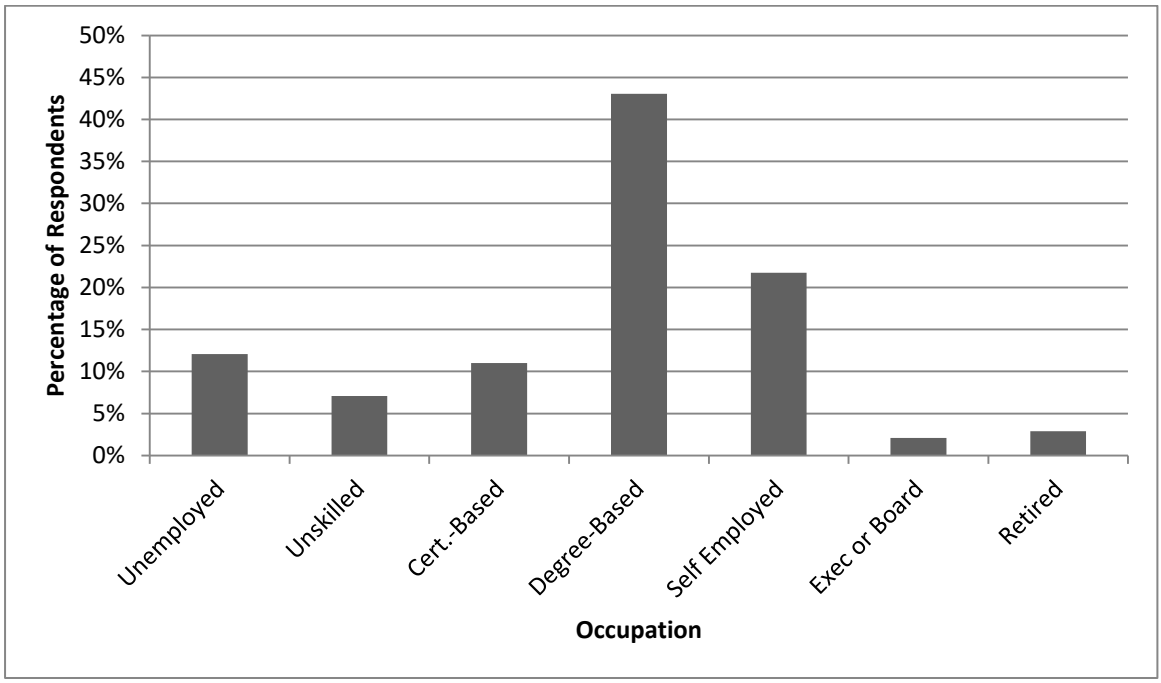
Figure 5.3: Level of education of the survey sample



Source: Author's data derived from survey responses.

As shown in Figures 5.3 and 5.4, a considerable number of respondents possess some form of degree, and they are employed in a field that requires a university-level education. The largest group of respondents possessed a Bachelor's Degree, with 41.7% indicating this as their highest level of education. When factoring in higher degrees such as the 21.8% who hold a Master's and the 7.1% which hold a Doctorate, a majority of approximately 70.6% of respondents have some form of university education. By contrast, only 14.7% have a high school-level education or lower, 7.9% have received some form of trade, technical, or vocational training, and 6.8% have an Associate-level degree, indicated a demographic skewed towards tertiary education.

Figure 5.4: Occupation of the survey sample



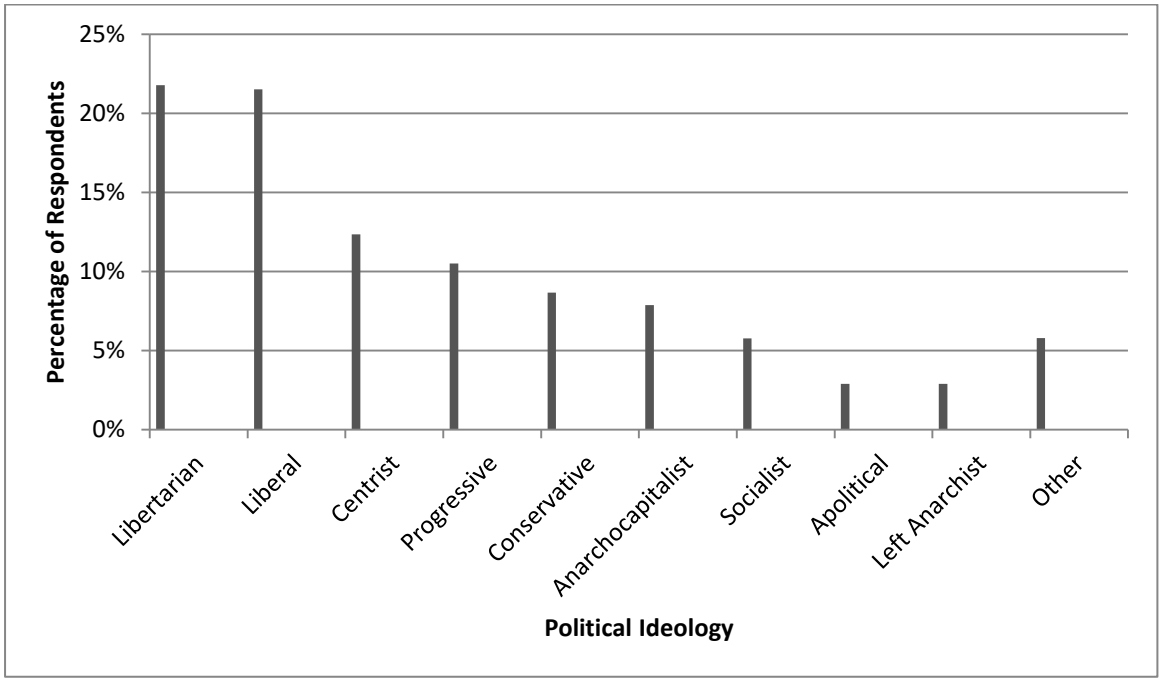
Source: Author's data derived from survey responses.

These educational factors are largely reflected in the demographics regarding respondent occupations, with 43% of respondents being in professional, degree-based employment and an additional 11% working in a field that requires skill certification. Unemployed and unskilled workers account for 12.1% and 7.1% of respondents respectively, while 21.8% are self-employed, 2.9% are retired, and 2.1% occupy an executive partner or board member position. Such figures suggest that the Bitcoin user base consists mostly of tertiary-educated individuals with occupations in a professional field or independent self-employment.

The survey also questioned respondents on their political ideology, asking them to choose the label that best described their beliefs from a list of options. A similar question was posed in the studies conducted by Smyth (2013; 2014), which appeared to confirm the popular perception of Bitcoin within and without academia that cryptocurrency is predominantly embraced by libertarians (Karlstrom, 2014). However, the Smyth (2013; 2014) studies offered a wide variety of options for

left-of-centre and right-of-centre respondents, while folding libertarians and anarchocapitalists under a single category. Subsequently, libertarian users appeared to be the most dominant group represented within the Bitcoin community, despite the fact that respondents who indicated a left-of-centre ideology would form a bloc of similar size if their categories were folded together. Rather than simplifying the political characterisations of Bitcoin users in order to address this issue, this survey has opted to expand the number of options available in the list for respondents to choose from, as well as including an 'Other' category that unrepresented users can fill in themselves.[54] The political leanings of the sample are presented in Figure 5.5.

Figure 5.5: Political ideology of the survey sample



Source: Author's data derived from survey responses.

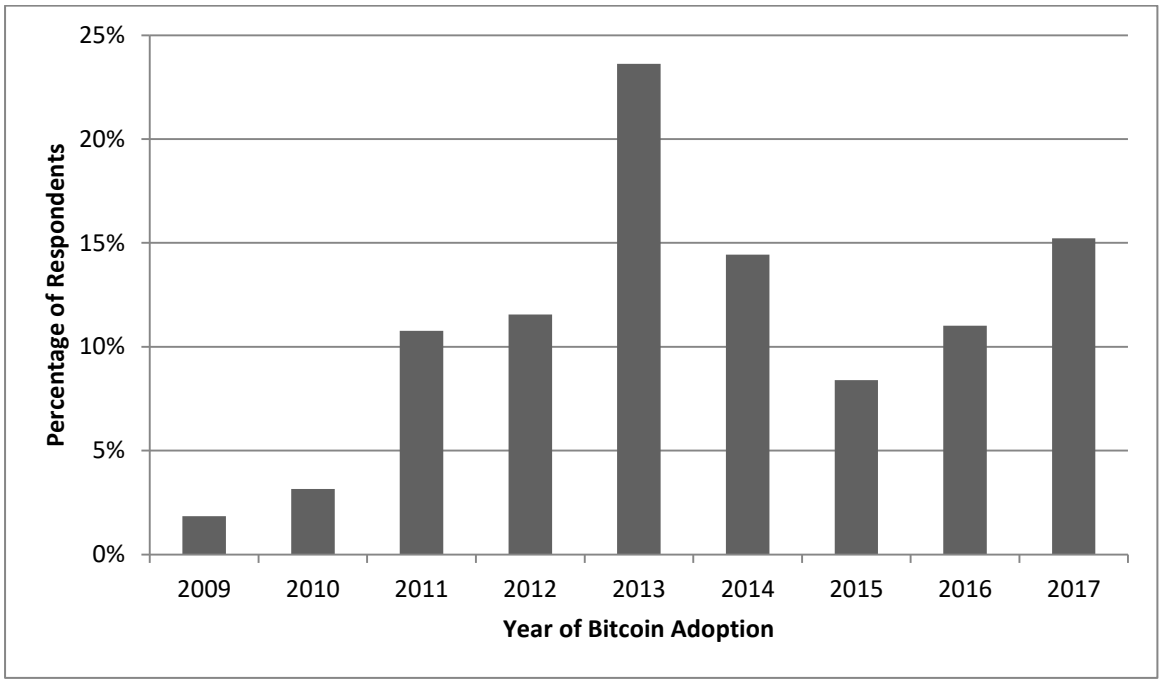
[54] In instances where answers in the 'Other' category corresponded with available options, they were folded together for analysis (for instance, an answer of 'Labour' was deemed to possess enough broad similarities to Centre-Left/Liberal to fit better in that category). Available options which received an insignificant number of selections were also folded under 'Other,' while the sufficient number of people describing themselves in various ways as 'apolitical' led to it being included in its own category on Figure 5.5.

As intended, broadening the scope of political categorisations enabled the raw data, at least on a cursory level prior to a deeper analysis, to encapsulate the range of diversity amongst respondents more accurately than the Smyth (2013; 2014) surveys. Libertarians remain the largest minority demographic represented within the sample, although they exceed the number of centre-left liberals by only one respondent – well within the margin of error given the sample size. In merging categories of overlapping political identity it is possible to attempt to identify a dominant ideological group within the user base. For instance, merging the libertarian and anarchocapitalist categories in the vein of the Smyth (2013; 2014) surveys creates a bloc of 29.7% of respondents. However, combining centre-left liberals with progressives increases their bloc to 32% of respondents, which could hypothetically be bolstered by socialists, left-anarchists, and others to form an even larger minority demographic – assuming one wishes to ignore the vast differences between these ideologies to encompass the gamut from centre-left to far-left, and libertarian to authoritarian (Evans and Heath, 1995). Although tinkering with political categorisations in such a manner may help simplify the data by identifying a dominant group – at least, in the broadest sense of the term – such manipulation comes at the expense of the individualised focus of the research and the complexity such behaviour entails. As such, in using this data as a demographic point of reference in later stages of the analysis, it is beneficial to accept the lack of a dominant politically ideological group as reflective of a diverse cryptocurrency subculture than it is to flatten the findings for the sake of deriving simplified observations. Setting these notions of ideological overlap aside, the composition of the survey sample embodies a broad range of ideologies across the left-right and libertarian-authoritarian spectrums, with centre-left liberals being the most prominent on the left and libertarians being the most prominent on the right.

The final questions in in the demographics section provide additional clarifying information on the relationship between each individual respondent and Bitcoin. The first of these questions asks

respondents the year in which they first started using Bitcoin, with the results displayed in Figure 5.6.

Figure 5.6: Bitcoin adoption rate of the survey sample by year

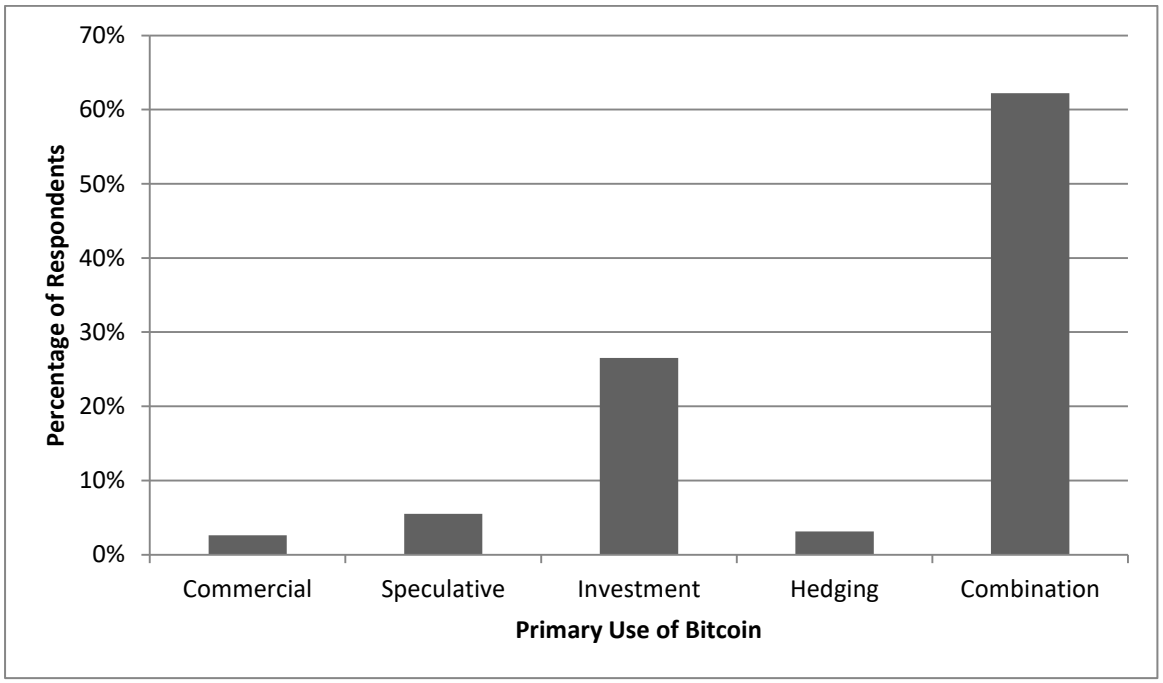


Source: Author's data derived from survey responses.

The survey managed to capture a cross-section of users from each year without any being underrepresented. With the exception of 2009, 2010, 2013, and 2015, each year is comprised of respondents representing a range between approximately 10-15% of the total survey pool. The largest such demographic group adopted Bitcoin in 2013, although the 23.6% of respondents in that category do not skew the data to such an extent that it suggests a sampling bias. The fewer responses from users who adopted Bitcoin in 2009 and 2010 is commensurate with this being the early adoption phase for the first cryptocurrency, during which time it had less name recognition and fewer users. The year with the fewest respondents to adopt Bitcoin after this period is 2015, although with 8.4% of respondents in this category, the survey has managed to capture an acceptable distribution of users from each twelve-month period.

Finally, respondents were asked to indicate the term that best described the manner in which they primarily use Bitcoin from a list of options. These included commercial (defined in the survey as "using Bitcoins to purchase goods and services"); speculative (defined as "making a profit from Bitcoin price fluctuations"); investment (defined as "making a profit from longer-term activities"); hedging (defined as "using Bitcoins to protect the value of your money/assets"); and every combination of some or all of the above.

Figure 5.7: Self-described primary usage of Bitcoin by the survey sample



Source: Author's data derived from survey responses.

As shown in Figure 5.7, an overwhelming majority of 62.2% of respondents indicated that some combination of the four best described the manner in which they use Bitcoin. The largest single factor usage of Bitcoin was investment, at 26.5% of respondents, with pure speculation, hedging, and commercial usage at 5.5%, 3.2%, and 2.6% of the user base respectively. A breakdown of the 62.2% of respondents who indicated their usage of Bitcoin involves a combination of factors likewise

followed the same trend. Almost every combination of options that made no mention of investment was indicated by respondents in less than 5% of instances, whereas commercial and investment was chosen by 13.7% of respondents; speculative and investment by 9.7%; investment and hedging by 7.35%; and all of the above by 11.8%. The only options to include investment that fell below this 5% threshold with the non-investment options were those that involved three factors, although this was a consistent theme throughout that entire category.

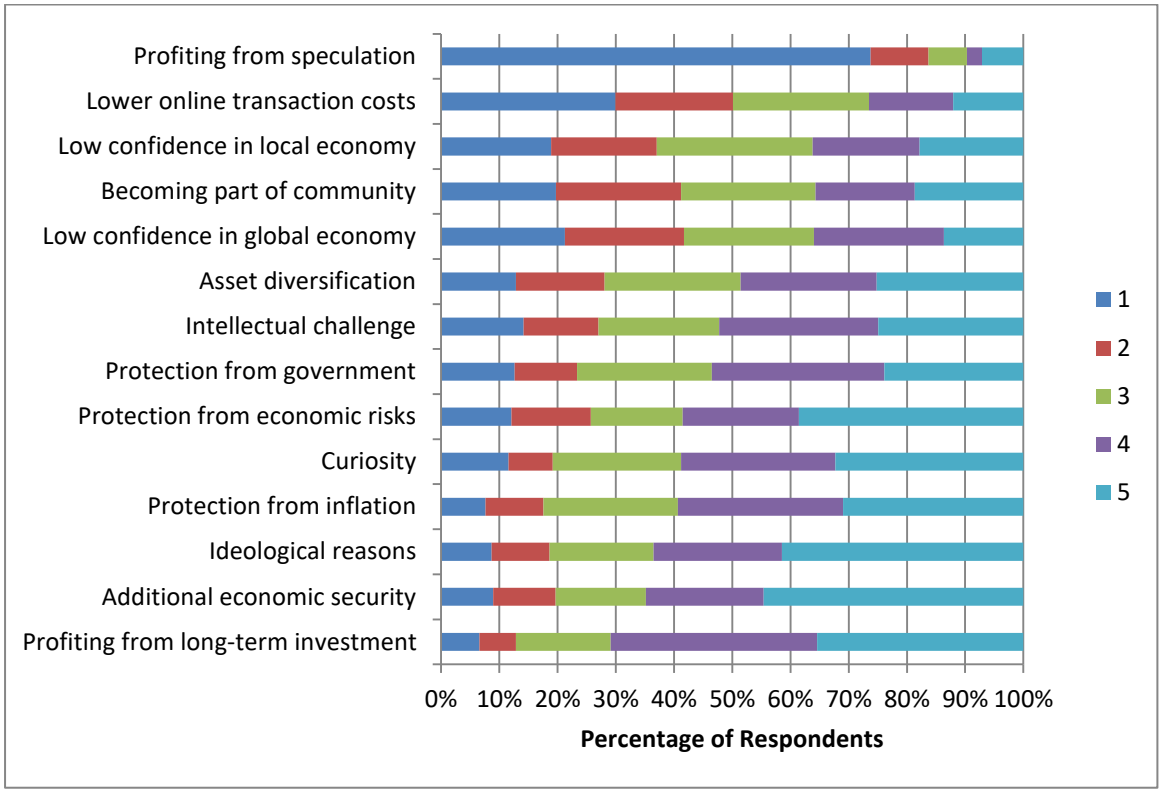
5.3. Trust and Confidence Amongst Bitcoin Users

In order to ascertain a view of the risk appreciation and investment preferences of individual Bitcoin users, the second portion of the survey asked respondents to rate a number of factors on a scale of one to five. The first such question asks respondents to rate the importance of particular factors in their usage of Bitcoin, using a scale of one to five. These factors are deriving a profit from mining Bitcoins; deriving a profit from speculating on changes in Bitcoin prices; deriving a profit from long-term investments; protecting yourself from the impact of inflation; protection yourself from government activities (e.g. seizure of assets); protecting yourself from risks in the mainstream (non-cryptocurrency) economy); providing additional economic security; lack of confidence in the local economy; lack of confidence in the global economy; diversifying your assets in an investment portfolio; lowering the cost of online transactions; ideological reasons, such as opposition to government and central banks; curiosity; seeking an intellectual challenge; and becoming part of a broader "Bitcoin community." Survey responses are presented in Figure 5.8, with a value of one being "not at all important"; two being "somewhat unimportant"; three being "neutral"; four being "somewhat important"; and five being "extremely important."

Commensurate with the findings of the semantic analysis, Bitcoin users appear to place more emphasis on longer-term investments than short-term profit making, with deriving a profit from long-term investments being the most important factor amongst 84.5% of respondents. By contrast,

deriving a profit via mining or speculating on changes in Bitcoin's value received the lowest scores, with only 9.7% and 26.5% of respondents deeming those activities important respectively. With regards to how Bitcoin is employed as an instrument of hedging, providing additional economic security was important to 70.9% of respondents, with 35.4% deeming it "extremely important"; protection from the impacts of inflation was important to 63.5%, with 41.2% deeming it "extremely important"; protection from risks in the mainstream economy was important to 58.8%, with 32.3% deeming it "extremely important"; and protection from government activities such as the seizure of assets was important to 58.5%, with 38.6% deeming it "extremely important."

Figure 5.8: Importance of cryptocurrency features to the survey sample



1 = not at all important	2= somewhat unimportant	3 = neutral	4 = somewhat important	5 = extremely important

Source: Author's data derived from survey responses.

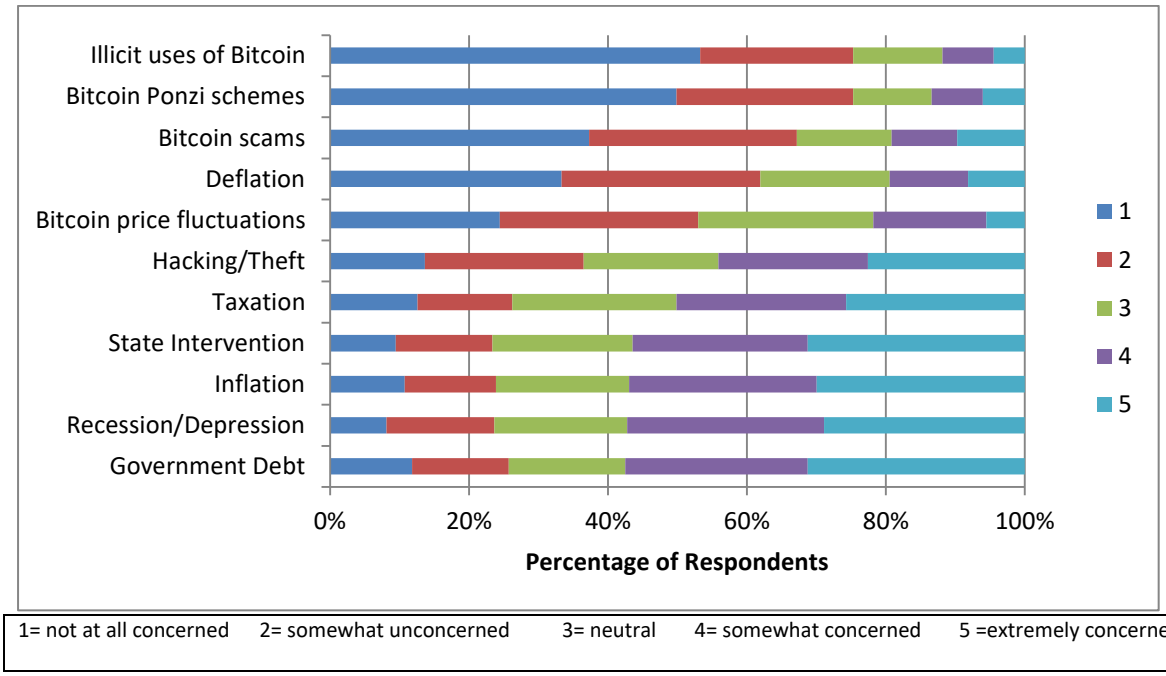
Regarding the notion of risk appreciation, 64.8% of respondents cited ideological reasons such as opposition to government and central bank control over money as important in their decision to use Bitcoin, with 44.6% deeming it "extremely important." With regards to Bitcoin as a long-term investment rather than a hedging instrument, 52.2% of respondents indicated diversifying their assets to include Bitcoin as part of a broader investment portfolio as important – less than the 84.5% of respondents who indicated the importance of making a profit from longer-term investments, but still a majority of the sample. Finally, attention should be given to the commercial function of Bitcoin as a medium of exchange. Lowering the cost of online transactions, a key portion of Bitcoin's commercial appeal, had a broad distribution of opinion, with 37% citing it as unimportant, 36.2% regarding it as important, and 26.8% remaining indifferent to this factor. This suggests, at least in part, a more investment-oriented appreciation of Bitcoin amongst respondents rather than regarding it in commercial terms.

The second question seeks to expand on the adoption motivation of users by determining how respondents perceive risks in both the mainstream and cryptocurrency economies. A list of factors was presented, with respondents asked to rate how concerned they are about each form of risk on a scale from one to five. These factors include inflation; deflation; taxation; government debt; recession/depression; hacking and theft of Bitcoins; becoming the victim of a Bitcoin scam; Bitcoin price fluctuations; Bitcoin Ponzi schemes; increased government intervention and regulation of Bitcoin; and the use of Bitcoin in illicit activities.

As shown in Figure 5.9, there is a delineation between the respondents' appreciation of risk in the mainstream economy and in the cryptocurrency market. Forms of risk related to the mainstream economy or the state intervening in Bitcoin were all deemed as areas of greater concern than those pertaining exclusively to cryptocurrency. With the exception of taxation, which was deemed an area of concern by 49.6% of respondents, government debt, the prospect of a recession or depression in

the mainstream economy, inflation, and regulatory intervention in the cryptocurrency market were all areas of concern for more than half of respondents; 58.2%, 54.9%, 55.9%, and 56.2% respectively. The different rankings between inflation and deflation are particularly noteworthy, given that fiat currency is prone to the former and Bitcoin the latter. Whereas 55.9% identified inflation as an area of concern, with 30.4% indicating they were "extremely concerned" about it, only 18.6% claim to be worried about deflation. Moreover, 65% are unconcerned to varying extents about the risk of deflation, with 35% indicating they are "not at all concerned."

Figure 5.9: Economic risk appreciation of the survey sample



Source: Author's data derived from survey responses.

All other forms of cryptocurrency-related risk are likewise not considered areas of concern, with 77.5% unconcerned about the illicit usage of Bitcoins; 79.4% unconcerned about becoming the victim of a Bitcoin Ponzi schemes; 69.6% unconcerned about becoming victim to a Bitcoin scam; and 56.9% unconcerned by the impact of Bitcoin price fluctuations. The risk of being the victim of hacking and theft of Bitcoins received a more varied distribution of scores, with 38.2% being

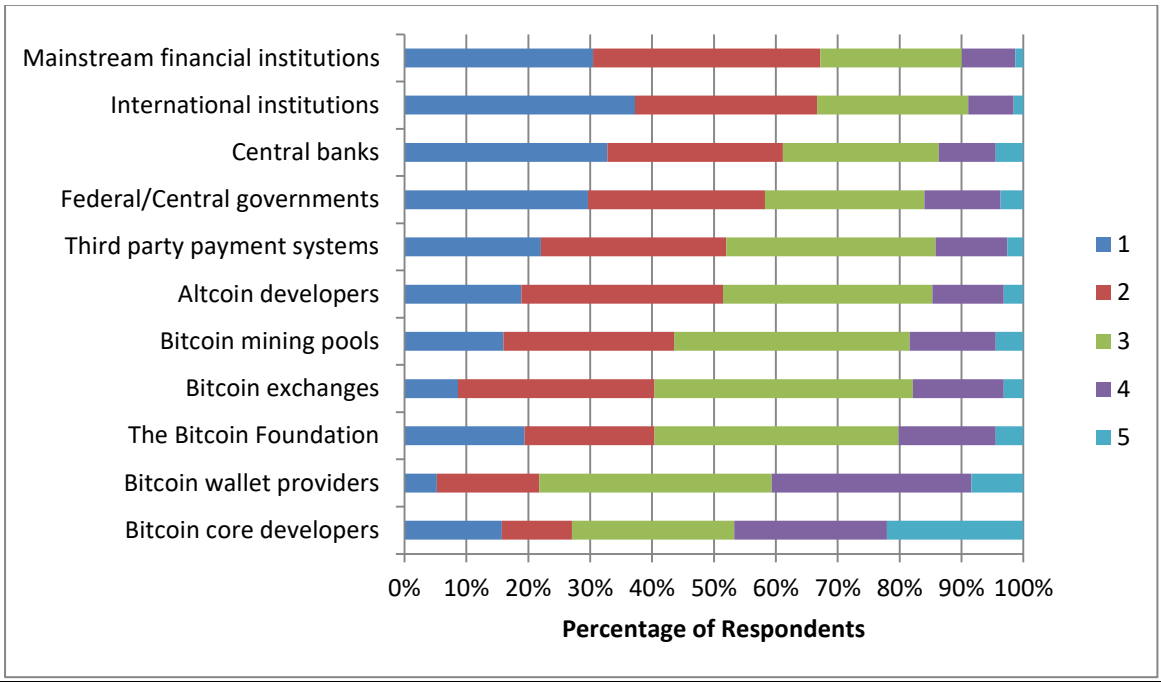
unconcerned by the prospect, 20.9% being indifferent, and 40.6% being concerned. Based solely on the findings of this section of the survey, it is inconclusive whether cryptocurrency-related forms of risk are less of a concern for respondents because they deem these hazards acceptable as per their subjective appreciation of hazards or they feel the extent to which these dangers are present is overblown in the media and public perception. However, specific questions dealing with this issue were included in the short answer question of the survey and responses will be outlined in Section 5.4.

The final question in the section on trust and confidence expands upon the risk perception of users by asking them to rate their level of trust in a number of state and private institutions, including those related to Bitcoin, on a one to five scale. The institutions chosen in this question are the federal or central government of their country of residence; the central bank of their country of residence; mainstream financial institutions (e.g. banks); third party payment systems (e.g. PayPal); international economic institutions (e.g. the International Monetary Fund or the World Bank); the Bitcoin Foundation; Bitcoin core developers; Bitcoin exchanges; Bitcoin wallet providers; Bitcoin mining pools; Altcoin developers. Responses are presented in Figure 5.10.

Unlike the preceding questions, which found a clear line of demarcation between Bitcoin and non-Bitcoin factors in the responses, trust in institutions of any kind amongst the user base is skewed in a negative direction. None of the chosen factors enjoy a confidence rating among users in excess of 50%, with only the Bitcoin core developers and Bitcoin wallet providers maintaining the trust of at least 40% of respondents. Nevertheless, despite a consistent deficit in confidence across the board, mainstream institutions are trusted less than those pertaining to the cryptocurrency market. Mainstream financial institutions such as banks were the most distrusted, with 67.2% of respondents indicating a lack of trust, followed by international economic institutions such as the IMF and World Bank at 66.7%. Central banks and federal or central governments were also deeply

distrusted, with 61.2% and 58.9% of respondents distrusting them respectively. Finally, payment systems underpinned by a third party to facility transactions – the very problem the blockchain was designed to solve – were distrusted by 52% of respondents, with 22% indicating 'no trust at all' in these private services such as PayPal and its competitors.

Figure 5.10: Level of institutional trust among the survey sample



Source: Author's data derived from survey responses.

Among cryptocurrency-related institutions, the developers of altcoins were the most distrusted, with 51.4% indicating their lack of trust in these groups.[55] Bitcoin mining pools, Bitcoin exchanges, and the Bitcoin Foundation were also broadly distrusted, with 43.6%, 40.4%, and 40.4% of respondents indicating a lack of trust in these institutions respectively. However, unlike non-cryptocurrency groups, these figures were tempered by the number of people indicating

[55] This is consistent with the findings of the semantic analysis in Chapter 4, which found that although there was a growing interest in altcoins in general amongst the user base over the long-term, specific alternatives to Bitcoin only received attention for short periods of time.

indifference to these institutions, with 38.1%, 41.7% and 39.4% assigning it a value of three respectively. In interpreting these findings, it is important to draw a line of distinction between an economic system and the constituent institutions which comprise it. Bitcoin users appear to distrust institutions across the board, at least for the most part, but still willingly engage in the market which these groups are inseparable from. Moreover, based on the preceding questions in this section, it appears that respondents are more concerned about mainstream economic risks than those present in the cryptocurrency market, institutional distrust notwithstanding.

5.4. Influential Factors Behind Bitcoin Adoption and Use

The final section of the survey consists of a short answer question that provides respondents with an avenue for offering their insights in an open-ended format. The section itself consists of ten questions, each designed to provide information pertinent to the research questions and/or to expand upon the findings of the semantic analysis in Chapter 4 that could not be addressed due to the passive observational methodology. In particular, the short answer section seeks to identify any other influential factors behind Bitcoin adoption not previously addressed by the survey; the respondents' primary concerns about the mainstream economy; the respondents' primary concerns about the cryptocurrency market; whether any specific economic events inspired respondents to adopt Bitcoin in the first place; whether they have ever used Bitcoin to protect the long-term value of their wealth from economic risks; what role, if any, Bitcoin plays as part of their investment portfolio; the extent to which they believe negative public perceptions about Bitcoin are accurate; whether they believe Bitcoin has evolved over time to address internal economic risks; whether the respondents use altcoins are for what purpose; and whether they believe that Bitcoin will one day come to be replaced by an alternative cryptocurrency.

In order to ascertain a view as to the effectiveness of the survey, the first question asks respondents "Were there other influential motivators behind your decision to use Bitcoin not mentioned in the

previous section. If so, what were they?" Of the 294 respondents, 42.6% indicated that their motivations were already expressed within the survey, while an additional 13.9% provided answers indicating topics that were already covered. In most instances, this was the result of oversights amongst the respondents, with some listing factors like ideological reasons or making a profit via mining. Others, however, provided responses which fell within the broad umbrella terms in the preceding section but with a greater degree of specificity; expanding on the previous examples, some offered deeper insights into their ideological reasons or emphasised the ability of mining to allow them to make a profit from home. One cited reason which could feasibly fall under the umbrella category of "ideological reasons" but received enough similar responses to merit individual attention is the "revolutionary potential" of Bitcoin. Of the remaining respondents, 14.3% cited their motivation for adopting Bitcoin as its potential to disrupt the established institutional order, whether through challenging the government and central bank monopoly on money or disrupting the traditional financial sector. This group of respondents was supported by an additional 5.4% who cited Bitcoin's ability to offer them financial sovereignty and economic freedom, some of whom felt that the current system was denying them that, and 4.8% who cited the transparency, decentralisation, and consensus system brought about by the blockchain.

An additional 3.4% candidly admitted that they were motivated to adopt Bitcoin due to its ability to facilitate the purchase of illicit goods over the darkweb. Naturally, rendering any moral or legal judgements based on this fact is outside the scope of this analysis, except insofar as criminal activity increases risks related to investments. However, one user clarified further by noting that:

> Early on I utilised the infamous Silk Road as an alternative to purchasing medication after I lost my health insurance. Being an American, this made adequate ongoing healthcare impossible. However, with the help of Bitcoin I was able to import medications to take care of myself and my family. Is it the right answer? Who knows, but it was right for me.

This demonstrates the potential of Bitcoin to open new commercial markets in circumvention of government regulations, a fact which increases risks through the prospect of government intervention and expands its commercial functionality. Although the research is unable to determine the extent to which such illicit motivations are reflected in the broader respondent pool, to say nothing of the Bitcoin user base as a whole, it stands to reason that there would be additional likeminded users who would not admit to such. An additional 1% of users cited the complementary fact that Bitcoin offers them a degree of pseudo-anonymity in their transactions, although this can have both legitimate and unlawful connotations. For instance, one respondent provided further clarification by noting that:

> Lack of traceability is nice for some uses. Not just illegal purposes. If I want to send money to some random person to fund something, such as a server hosting content about the Armenian Genocide or the Tiananmen Square Massacre, it can be useful not to have that be traceable.

Beyond those groups, 3.4% claimed that they adopted Bitcoin based on the recommendations of a trusted relative, friend, or public figure; 2% cited its ability to provide economic opportunity usually unavailable to people of their demographic background due to the lack of entry barriers; 1.7% cited a greater ease in making international monetary transfers than mainstream banking or payment systems offer; 1.4% admitted it was fun; and the remaining 4.6% fell under the category of "Other" due to their responses being unique to the individual respondent.

To ascertain a view of the risk appreciation of users, the second question asks respondents "What are your main concerns about the state of the mainstream economy today, both locally and globally? Why do these issues concern you?" Responses to this question were mixed, although the most commonly cited concerns were the same as those outlined in the confidence rankings of the preceding section. Of these, 16.3% of respondents cited the level of government and household debt, 15.3% cited inflation, 13.6% cited a belief that mainstream institutions such as governments,

central banks, and financial service providers were corrupt and rigging the economy, and 11.9% cited a general distrust in fiat currencies and the state monopolisation of money. These figures were bolstered by an additional 7.1% who believed that there would soon be a major collapse of some form in the mainstream economy. The remaining respondents took a more partisan stance in listing their concerns, raising issues associated with the left/right economic divide. Of these, 4.1% cited rising income inequality, 3.1% cited big government, 1.7% cited the rise of far-left and/or far-right political groups, 1.7% cited job losses created by increasing automation of the labour market, 1.7% cited the profit-driven nature of capitalism, and two groups of 1% each cited taxation and the push towards a cashless economy. Of the remaining respondents, 14.3% claimed to have no real concerns at all – or, as one respondent put it, none besides the "usual" worries – and 7.1% cited niche personal issues. In interpreting these findings, the risk-aversive nature of the sample becomes evident: whereas only 14.3% claimed to have no concerns about the state of the mainstream economy worth mentioning, 87.5% identified a number of concerns which Bitcoin can be used to hedge against.

Although the respondents' concerns regarding the mainstream economy are significant given the underpinning research questions, determining their perception of the cryptocurrency market is also pertinent. As such, the third question asks respondents "What are your biggest concerns about the state of the cryptocurrency market today? Why do these issues concern you?" Responses to this question were varied, but the largest group consisting of 19% of respondents indicated fears of more government intervention into the cryptocurrency market. Concerns in this category ranged from worries that future regulatory frameworks would be too restrictive or poorly thought out to fears of an outright ban on cryptocurrencies. By contrast, only 1% of respondents cited the lack of regulatory clarity surrounding Bitcoin, especially in regard to ensuring that their tax payments are compliant with existing legal expectations. The second largest concern was the scaling debate, which pertains to an artificial cap on the size of contributions to the blockchain, and the subsequent infighting

which has divided the Bitcoin community since this became an issue.[56] However, most respondents neglected to state which side of the debate that they personally agreed with, with the driving concern appearing to be the level of infighting brought about by it and the inability to reach a consensus. This in turn leads to the next largest concern, with 17% of respondents expressing concern over the centralisation of mining pools and the consequently disproportionate influence these groups wield over decision-making. Indeed, as noted by Blundell-Wignall (2014), the decentralised and transparent nature of the blockchain creates a "trust-less" system under which Bitcoin users do not have to rely on the integrity of a third party, with users feeling that mining centralisation poses a threat to that underpinning ideal.

Along with these larger concerns, there were a number of other issues which merit attention. The next largest bloc of respondents cited altcoin scams, with 9.5% indicating a distrust of cryptocurrency alternatives to Bitcoin. These respondents felt that many altcoins were created by those seeking to profit at the expense of others through means such as fraudulent initial coin offerings, more commonly known as ICOs, which would in turn damage the perception of cryptocurrencies including Bitcoin with negative publicity and less adoption. A further 9.2% of respondents cited the lack of widespread adoption of Bitcoin amongst both users and mainstream commercial retailers, with some suggesting that poor ease of use was partially to blame. As one respondent put it, the "increasingly profit-driven sentimentality in new users [is] driving widespread misinformation about opportunities and failures [in the Bitcoin market]." However, this figure contrasts with 3.1% of respondents who cited the opposite problem: namely, that there were too many new users motivated by the desire to get rich quick. These respondents argued that such users

[56] The scaling debate stems from an artificial cap of 1 MB of data per block contributed to the blockchain. Critics believe that as the user base has grown, this cap only serves to slow the number of transactions that can be added to the blockchain at once, increasing the time and cost of processing payments. Proponents argue that removing the cap will result in the centralisation of power under mining pools, while changing the cap, which requires a majority of nodes in the system to approve the changes, risks causing a consensus failure.

are attracted to Bitcoin by news coverage documenting the rise in its price, fall for scams that more experienced users would be able to spot, and subsequently bring negative publicity to the cryptocurrency due to their own human errors. Of the remaining respondents, 3.1% cite volatility as their biggest concern; two different groups of 2.7% cite what they perceive to be the poor management of the Bitcoin core developers and the potential for a future Bitcoin market crash; 2.4% cite security concerns related to hacking, especially in regard to exchanges; two additional groups of 1% cite speculation and the potential for further forks in the blockchain; 3.1% cited other concerns below the threshold for inclusion; and 6.8% claimed to have no concerns at all regarding the state of the cryptocurrency market.

In order to determine the extent to which these current concerns influenced the respondents' decision to adopt Bitcoin, the fourth question asks "Did any specific economic event lead to your decision to start using Bitcoin? This can include localised conditions within your region or broader global concerns. If so, please specify." Breaking down responses to this question on a purely "yes/no" basis, 60.9% of respondents indicated that there was no singular event which led them to start using Bitcoin, whereas 39.1% could point to such an incident. Breaking these responses down further, 13.3% specifically singled out the 2007-2008 financial crisis, also referred to as the Global Financial Crisis or GFC, and its aftermath period. Other specific events that received significant mentions include the 1.4% that cited the Greek debt crisis in Europe, the 1% who cited the Cypriot banking crisis and subsequent bail-ins, and the 1% who cited the United Kingdom's decision to leave the European Union, colloquially known as Brexit. An additional 7.1% mentioned less prominent or specific localised economic problems, with a further 5.1% citing problems in the banking sector of their country of residence, 2% referring to the level of nation debt in their country of residence, and 1.4% indicating the level of inflation in their country of residence. On the more positive side, 4.8% indicated that they started using Bitcoin after hearing favourable news coverage about the

cryptocurrency, while the remaining 2% indicated that there was an unspecified event that led them to use Bitcoin but did not elaborate any further than that.

Expanding upon the preceding question, with a greater emphasis on the extent to which such events influence hedging behaviour, the fifth question asks respondents "Have you ever used Bitcoin to protect the long-term value of your wealth from some perceived threat? If so, what and why?" Breaking responses down on a purely yes/no basis, it was found that 52.8% of respondents have not used Bitcoin as a means of protecting their wealth, while 47.2% have in some capacity. Breaking down the responses further to determine specific causes, it is possible to identify the key areas of concern for those engaging in hedging activity. The largest such concern was inflation, with 20.7% of respondents indicating that they had used Bitcoin to protect the long-term value of their wealth from such devaluation. This was the largest concern by far, with 4.1% indicating that they had used Bitcoin to protect their wealth from government threats of an unspecified nature, and an additional 2.7% specifying some form of taxation or state seizure; 3.1% indicated that they were protecting their wealth from an unspecified upcoming financial collapse, with a further 2% specifying that they believed this would be a collapse of the dollar and/or fiat currencies in general; 2.4% indicated a localised economic concern; and 2% indicated that they were protecting themselves from banks, whether due to a general distrust or more specific bail-in/bailout policies. The remaining 10.2% only indicated that they had used Bitcoin to protect the long-term value of their wealth, but failed to elaborate any further on what or why.

In order to determine the manner in which Bitcoin users regard and utilise cryptocurrency as a form of investment, the sixth question asks respondents "Do you use Bitcoin as part of an investment portfolio? If so, what role would you describe Bitcoin as playing in your investment activities?" Expressing the results in a purely yes/no basis, 76.9% of respondents claim to use Bitcoin as part of their investment portfolio, while the remaining 23.1% do not. However, the prompt may have

required clarification, as some respondents opted to express the role Bitcoin plays in their portfolio while others instead outlined how much of their portfolio consists of Bitcoin. 10.5% described Bitcoin as the only investment they own without citing how they used it, 20.4% described it as a major investment, and 12.2% described it as a minor investment, often as a means of diversifying a larger portfolio which also includes more traditional assets. Amongst those who specified the role Bitcoin plays, 8.8% described it as a long-term holding, 8.5% described it as a hedging instrument with nearly a third of those claiming it fills a similar role to gold in their investments, and 7.1% described it as the "high risk, high reward" component of their portfolio which they predominantly use for speculation and day trading. The remaining 5.8% claimed that Bitcoin is by them as part of an investment portfolio, but neglected to elaborate on the extent or role it plays in that regard.

The seventh question asks respondents "To what extent do you believe that the public perception of Bitcoin as being volatile, prone to cybercrime, and used in illegal activities, is accurate?" In response, 41.8% of respondents claimed to find that perception completely inaccurate, while an additional 9.5% found it mostly inaccurate. An additional 19.7% conceded that there was a small grain of truth to the statement, especially regarding Bitcoin's volatility, they found the perception inaccurate and somewhat exaggerated, particularly within the media. Combined, this suggests that over two-thirds of respondents believe that the mainstream perception of Bitcoin is inaccurate to varying extents. By contrast, only 8.8% found it completely accurate, 1.7% found it mostly accurate, and 12.9% deemed it accurate but largely irrelevant. Amongst those who found this perception accurate or at least partially accurate, most agreed with the notion that Bitcoin is volatile – although many justified this is a natural expression of supply and demand, or a consequence of the lower ratio of investors to commercial users relative to fiat currencies – but denied that illicit use was uniquely problematic. An argument that respondents commonly made was expressed by one of them as follows:

> Much like the internet was built on the back of pornography, Bitcoin was built on the transactions of hackers and drug users… [Now] Bitcoin is accepted by Amazon and Overstock, as well as Newegg.com The technology is going mainstream and leaving behind its sortid [sic] past.

Others chose to make comparisons to fiat currency, noting that many criminals simply traded in cash without anyone subsequently questioning the legitimacy of physical money. Of the remaining respondents, 2% were in the middle and believed it to be half-true, while 3.4% admitted to being uncertain.

One of the main findings of the semantic analysis was that the Bitcoin market had gradually evolved over time, an observation backed up by Tasca, et al. (2018) who traced the evolution of Bitcoin from the early adoption phase to the "sin" market phase to one of increasing legitimisation. Expanding upon this theme and the preceding question, the eighth question of the survey asks respondents "Do you believe that the Bitcoin market has changed over time to better combat the dangers specified in the question above? Please provide examples to explain your reasoning." Breaking the responses down on a yes/no basis, 58.1% believed that the Bitcoin economy had changed over time, 27.6% believed that it had not, and 14.3% were uncertain. The most commonly cited change was increases in security, with 19.7% citing improvements in security software to prevent hacking and users becoming better aware from previous instances on how to safely handle their Bitcoins. One respondent in this category cited a recent example of hacking and compared it to more high profile incidents in Bitcoin's earlier years, noting that "Bitfinex seems to have handled their hack better than past examples." Commensurate with the findings of the semantic analysis data analysis chapter and the study by Tasca, et al. (2018), 14.6% of respondents identified a transition over time from illicit to more legitimate use, citing the increasing number of commercial outlets which accept Bitcoin as a form of payment. This result was reinforced by the additional 7.1% of respondents who cited the introduction of "Know Your Customer" and "Anti-Money Laundering" legislation,

commonly referred to by users as KYC/AML laws, in a number of jurisdictions. While the extent of such legislation varies on a jurisdictional basis, KYC/AML laws typically require exchanges to form a registry of their clients and ask for photo identification prior to allowing users to open an account. One respondent cited all three changes in their answer, expressing the changes to the Bitcoin market as follows:

> Broader popular adoption has lead [sic] to increased decentralisation of the exchanges between Bitcoin and the fiat currency economy. Instead of having a single dominant (and, in retrospect, laughably poorly run) exchange in Mt. Gox, there are now dozens, even hundreds worldwide, many of which comply fully with the economic regulations and laws of their jurisdictions. Understanding the system that underpins the Bitcoin-based economy has actually grown among governments, courts, and law enforcement agencies… Law enforcement agencies are actually finding the block chain's inherent transparency can [be] a useful tool in tracking down criminal elements. The recent arrested [sic] of the head of the BTC-e exchange may be a case in point.

Regarding the issue of volatility, 4.1% of respondents argued that the price of Bitcoin had grown more stable over time, with many attributing this to an increase in the user base across the same period. This finding is reinforced by an additional 3.4% of respondents who cited changing public perceptions of Bitcoin, with more people coming to regard it as legitimate and subsequently adopting it. Of the remaining respondents, 8.2% cited a belief that the Bitcoin market had evolved but provided no examples, and 1% cited another reason which fell below the threshold of significance.

The ninth questions examines the respondents' experiences with altcoins, asking "Do you, or have you in the past, used any cryptocurrencies other than Bitcoin? If not, why not? If so, which cryptocurrencies do you use and why?" On a yes/no basis, 77.2% of respondents indicated that they had previously used altcoins, while the remaining 22.8% indicated that they had not, suggesting a high degree of interest and acceptance of alternative cryptocurrencies amongst Bitcoin users. The

number of altcoins identified by the respondents is too large to be concisely outlined – indeed, a number of respondents refused to list the altcoins they used when answering the question for just such a reason. However, the most prominent examples include Ethereum (used by 44.5% of respondents), Monero (used by 11.2%), Dash (used by 7.8%) and Ripple (used by 4.4%). Of greater interest to the analysis is the manner in which respondents use their altcoins in comparison to Bitcoin, or why they do not use them at all. The most commonly cited reason was better provisions for privacy and pseudo-anonymity, with 9.9% of respondents citing such factors as KYC/AML laws and exchanges trying to improve their reputation for legitimacy making altcoins a more attractive alternative for maintaining financial privacy.[57] Amongst those motivated by investment reasons, the largest group of 9.5% claimed to use altcoins for speculation and day trading, with some elaborating that this behaviour was unique to altcoins and they used Bitcoin for other purposes. For comparison, 6.1% cited diversification of their cryptocurrency holdings, 5.4% claimed to hold altcoins for long-term investments, 3% used altcoins for hedging, and 2% employ altcoins for commercial transactions. Of the remaining respondents in this category, 1.7% were simply motivated by curiosity and 1% claim to prefer altcoins over Bitcoins but provided no further clarification on the reasons why. Finally, 8.2% of respondents indicated that they had previously dabbled in the use of altcoins, but found they preferred Bitcoin and no longer used other cryptocurrencies. Amongst the respondents who do not use altcoins, 16.3% did not specify why, 5.4% cited a distrust of altcoins and the belief that many of them are scams, and 1% expressed an interest in diversifying into altcoins in the future but had not yet done so.

In order to ascertain a view of the long-term risk appreciation of Bitcoin users, with respect to internal threats in the cryptocurrency market such as competition, the final question asks respondents “Do you believe that over the long term, Bitcoin will come to face stronger competition

[57] There was a noted overlap between these respondents and those who claimed to use Monero, which was designed with privacy protection of its users in mind.

from other cryptocurrencies or even be replaced by a more successful alternative. Why or why not?" On a yes/no basis, 41.8% of respondents indicated a belief that Bitcoin would not be replaced, 40.8% expressed the belief that it would over the long term, and the remaining 17.3% were uncertain. On the no side of the debate, the most commonly cited reason for why it would not be replaced was because no other altcoin could easily challenge the network size, established brand, and first mover advantage that Bitcoin enjoys, with 34.4% of respondents expressing this opinion. As one respondent elaborates:

> There will be many speculators introducing new versions of Bitcoin, but if one really understands the technology behind Bitcoin, [then] Bitcoin is the only cryptocurrency that can hold value in the long term. A blockchain without a competent group of developers; wide distributed network of nodes; sizeable network hashing rate[58]; distributed pool of miners with proper incentive structures will eventually fail to: A. Hostile contentious hard forks, B. Sybil attacks[59], C. Systemic corruption, [or] D. All of the above.

Another respondent expressed the argument more succinctly by noting that "The main driver of a currency is adoption. Bitcoin is far ahead in that regard. Other coins might be faster with implementing exotic features, but they will have a hard time to get the user adoption that Bitcoin has." Of the remaining respondents in this category, 1.4% noted that Bitcoin can assimilate new technological advances pioneered by other altcoins through the consensus system of upgrades; 1.4% expressed the belief that altcoins have nothing to offer and/or a sizeable number of them are scams; and 4.8% provided no reason for their position. Amongst the respondents who answered yes, the most commonly cited argument was that technological advancement over the long term would inevitably render Bitcoin obsolete at some point, with 27.6% of respondents holding this position. As

[58] The hash rate refers to the speed at which a device is capable of completing an operation in the Bitcoin code.

[59] A Sybil attack is a form of cyberattack where a reputation system is undermined by forged identities within the P2P network.

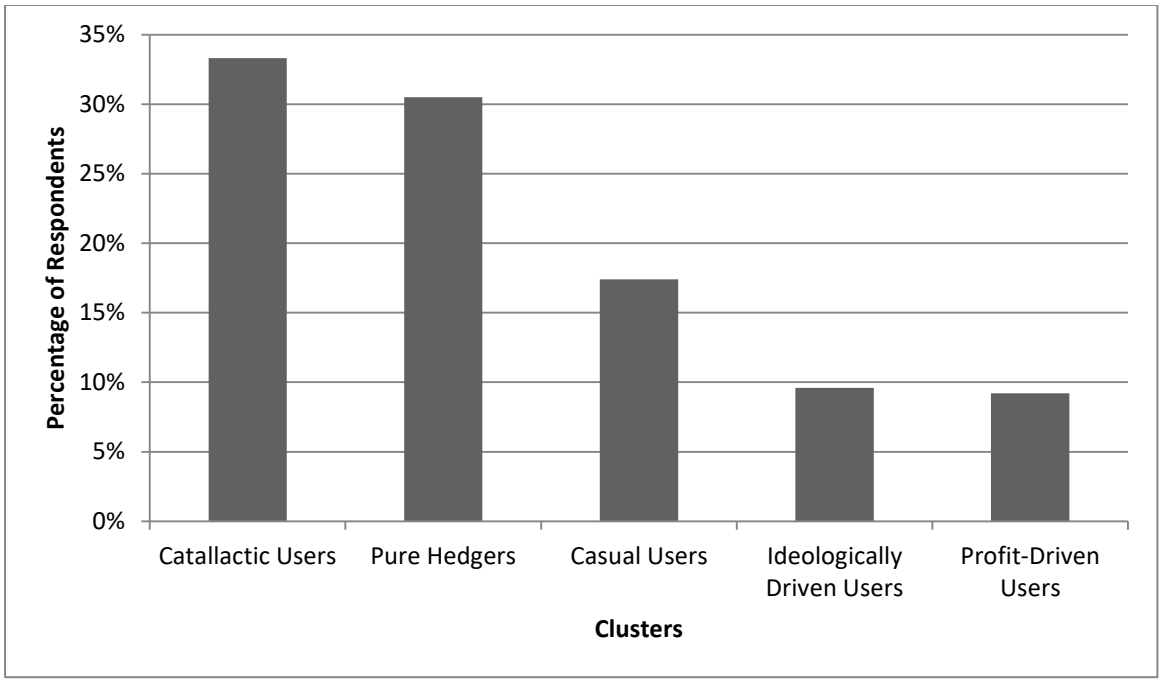
one respondent put it “Oldsmobile was the first mass produced automobile in the U.S. and an iconic American brand, yet there hasn’t been an Oldsmobile sold in over a decade.” Of the remaining respondents, 4.4% argued that Bitcoin would face greater competition due to altcoins being able to adopt specialised roles to satisfy niche market demand; 2% argued that Bitcoin would be replaced over the long term due to the perceived incompetence of its core developers; 1.7% cited its lack of scalability, arguing that the inability to resolve processing times and costs for transactions could provide an opening for a competitor; and 4.8% offered no explanation of their position.

5.5. Cluster Analysis Based on Areas of Overarching Commonality

Although analysing the answers of the respondent base as a whole provided insights relevant to the research questions, such an overarching approach fails to capture the diversity of views indicated in the data. In order to ascertain a better view of the number of subgroups represented within the survey pool and their size relative to one another, the study will employ cluster analysis, a statistically method of breaking the respondents down into “clusters” based on areas of overarching commonality (Kaufman and Rousseeuw, 2015). Each respondent’s answers in the short answer section of the survey is assigned to an overarching category (e.g. negativity towards mainstream risk; profit-motivated; hedging activity, etc.) and given a score based on the percentage of their total answers which fall in each category. From there, respondents are divided up into clusters with others whose scores indicate that they share similar motivations and views pertaining to Bitcoin. Through the application of this approach, it is possible to divide the total survey sample into five clusters of commonality. These are dubbed, for reasons described further herein, as: catallactic users, pure hedge users, casual users, ideologically-driven users and profit-driven users. Of these groups, 33.3% of respondents were identified as catallactic users; 30.5% were identified as pure hedgers; 17.4% were identified as casual users; 9.6% were identified as ideologically-driven users; and 9.2% were identified as profit-driven users.

Of the 294 respondents employed for analysis in this section, 12 could not be assigned to a cluster due to a lack of clarifying information in their responses making it impossible to reliably categorise their views and behaviour. The clusters comprising the 282 remaining respondents are presented in Figure 5.11.

Figure 5.11: Representation of cluster sizes within the survey sample



Source: Author's data derived from cluster analysis of survey respondents.

The largest cluster, comprising exactly one-third of respondents, consists of what have been termed by the researcher as "catallactic users." Consistent with the view of Bitcoin as a hedge, catallactic users have a high percentage of responses to the short answer section of the survey which indicate that they are aversive to particular forms of risk in the mainstream economy, with those concerns being influential in their decision to adopt Bitcoin. Although this suggests hedging behaviour, catallactic users are distinguished by an equally high percentage of their answers indicating varying degrees of voluntary risk-taking, including the use of Bitcoin for long-term investments, employing altcoins for speculation purposes, and also commercial activities. The catallactic users are

emblematic of a theme that has commonly appeared throughout the interpretation of the data, both within the semantic analysis and survey. Namely, that while the adoption of Bitcoin itself appears to be a predominantly risk-aversive activity, such an act only constitutes the first step in users transferring their voluntary risk-taking activities from the mainstream economy to the cryptocurrency market.

The next largest cluster, comprising 30.5% of respondents, consists of what could be described as "pure hedge users." As the name implies, their motivations for adopting Bitcoin and subsequent investment behaviour consist entirely of risk-aversion and hedging. Like catallactic users, pure hedgers are distinguished by a high percentage of answers indicating an aversion to risks associated with the mainstream economy, with these factors also being influential in their decision to adopt Bitcoin. The primary point of divergence is the manner in which they employ Bitcoin, with their behaviour characterised by an absence of risk-taking activity and the use of Bitcoin as a means of protecting themselves from mainstream risk. Pure hedgers are also more likely to compare Bitcoin to gold when describing its role in their portfolios, tend to distrust altcoins as being scams or having no inherent worth, and believe that Bitcoin will maintain its dominance of the cryptocurrency market due to its greater function as "virtual gold" compared to its competitors.

The third largest cluster, which is comprised of 17.4% of respondents, consists of what can most accurately be described as "casual users." Unlike the preceding clusters, casual users are the least likely to have an ideological or practical distrust of mainstream institutions, have few concerns about the mainstream economy, and, insofar as they do, these factors were not deemed influential in their decision to adopt Bitcoin. As such, these users do not use Bitcoin as a hedge to protect themselves from particular forms of economic risk or to realign their risk-taking activities with a market more in line with their risk appreciation. Furthermore, casual users are not predominantly driven by a profit motive. Instead, casual users represent a middle ground between these groups, having a high

percentage of answers which indicate positive feelings towards both the mainstream economy and Bitcoin. The primary motivation of casual users appears to be that Bitcoin possesses features which they find useful in their economic activities, with particular regards to the features of the technology as opposed to the market itself. For instance, casual users are the most likely to engage in commercial activities, with a number of respondents indicating that a particular difficulty in dealing with a local bank or payment system led them to adopt Bitcoin. Such concerns relate more to matters of practical convenience than significant events that undermined their faith in the entire institution, however. A recurring example of this is the number of users who noted that it is easier to use Bitcoin to make international transfers and payments between states that use different currencies than it is to do so through a bank. Insofar as casual users invest in Bitcoin, it is typically only a small portion of a broader portfolio, with many respondents in this category indicating that the majority of their portfolios are comprised of more traditional assets.

The fourth largest cluster, which is comprised of 9.6% of respondents, consists of what the researcher has termed "ideologically-motivated users." As the name suggests, the motivations of respondents grouped within this cluster are predominantly ideological in nature, underpinned by a particular distrust in mainstream institutions such as governments, central banks, and politically-connected private firms. Consequently, these respondents are highly aversive to risks in the mainstream economy, and cite these factors as influential in the decision to adopt Bitcoin. Along with these external concerns, ideologically-driven users are more likely to cite the "revolutionary potential" of Bitcoin as a disruptive force in institutionally-governed mainstream markets. Although such behaviour is consistent with either the catallactic user or pure hedger clusters, ideologically-driven users have been assigned to their own category due a lack of clarifying information regarding the manner in which they use Bitcoin as a form of investment. While the attitudes of respondents in this category are positive towards Bitcoin, and they cite mainstream risks such as inflation that cryptocurrency can be used to hedge against, the lack of specific details on their investment activity

makes it difficult to assign them to another cluster with any degree of certainty. This fact, combined with the indication of a strong ideological connection to Bitcoin, has resulted in these respondents instead being assigned to their own cluster, with the caveat that they might have fallen under the category of catallactic users or pure hedgers had their responses been more specific.

The smallest cluster, comprising 9.2% of respondents, consists of what can most accurately be described as "profit-motivated users." As the name suggests, profit-motivated users are the respondents whose motivations for using Bitcoin revolve around their ability to use it to make more money, predominantly via speculative activities and mining. Like casual users, profit-motivated users are among the least likely to have concerns regarding the mainstream economy, but they are also less likely to associate Bitcoin with any positive traits. The sole exception to this latter point is the ability of Bitcoin to provide economic opportunities, with some respondents in this category noting that it offers a means of making amounts of money that would not normally be available to people in their socioeconomic strata.[60] For instance, one respondent noted that they had their computer on all day anyway even before using Bitcoin, which made it an easy and accessible way to make money through mining. Nevertheless, with the exception of the small percentage of respondents who cited such positive points, profit-driven users are characterised by a high percentage of answers indicating high-risk, high-reward investment activity, and an indifference to the aspects of cryptocurrency outside this area of interest. Similarly, profit-driven users are among the most likely to use altcoins, particularly for the purposes of speculation and investment. Due to the data collection approach employed by this research, it must be acknowledged that this group may be larger in the overall cryptocurrency user base than is represented in the survey sample. After all, individuals motivated purely by making a profit from cryptocurrency without an ideological or community connection to Bitcoin are probably less likely to frequent the online forums targeted for data collection. However,

[60] Given the proportion of highly-educated, professionally-employed users represented within the survey sample, it should be noted that such comments came from respondents who do not belong to these majority groups (e.g. possessing lower levels of education and being unemployed or having an unskilled occupation).

although such users are most likely underrepresented within the data, the findings derived from the survey and the semantic analysis suggest that the focus on such activities is also disproportionate given the sizeable body of users with a longer-term focus on hedging and investment.

5.6. Individual Determinants of Cluster Allocation

In order to determine the extent to which demographic factors influence assignment to a cluster, each identified subgroup is broken down based on the respondents' answers to section one of the survey. The composition of each cluster is then be compared to that of the survey sample as a whole, which acts as a baseline figure for identifying points of divergence. Due to the limited sample sizes available, only the catallactic users and pure hedge users are incorporated into this stage of the analysis, as the others are too small to produce reliable data.

This analysis begins with catallactic users, which comprise the largest bloc of survey responses. Of the 94 individuals within this category, 94.7% were male and 5.3% were female. Regarding their age distribution, 36.2% were aged 18-29, 45.7% were aged 30-39, 12.8% were aged 40-49, 2.1% were aged 50-59, and 3.2% were aged 60-69. With respect to their country of residence, 34% were from the United States, 16% were from Australia, 9.6% were from Germany, 5.3% were from the United Kingdom and Canada, 3.2% were from New Zealand and Poland, 2.1% were from Ireland, the Netherlands, and the Czech Republic, and 1.1% were from Switzerland, Denmark, Bulgaria, Spain, Malta, Austria, Portugal, Lithuania, Greece, Norway, Sweden, South Korea, Brazil, and Ghana. The level of education of the respondents was 17% with a high school graduation or lower, 12.8% with trade, technical, or vocation training, 6.4% with an Associate degree, 40.2% with a Bachelor's degree, 17% with a Master's degree, and 6.4% with a Doctorate. Regarding the occupations of the cluster, 17% were unemployed, 7.4% were in unskilled employment, 17% were in skilled certificate employment, 33% were in professional degree-based employment, 28.7% were self-employed, 1.1% were executive partners or board members, and 2.1% were retired. And finally, the political views of

the respondents were 23% centre-left/liberal, 20.2% libertarian, 16% centrist/moderate, 11.7% progressive, 8.5% anarchocapitalist, 6.4% socialist, 5.3% apolitical, 4.3% centre-right/conservative, 2.1% anarchocommunist/anarchosyndicalist, and 1.1% were communist.

In breaking down the demographic base of catallactic users, many of the variables are consistent with the baseline established from the survey sample as a whole. The gender, country of residence, level of education, and occupation of the catallactic users cluster are all consistent with the male-dominated, Western-oriented, and professionally educated and employed baseline demonstrated by the survey pool. However, two demographic factors stand out for their deviation from these figures: age distribution and political ideology. Although the age distribution of catallactic users is also skewed towards a younger demographic, the largest group consists of 30 to 39 year olds, compared to the 18 to 29 age bracket which was dominant in the broader survey pool. In fact, 30 to 39 year olds represent 45.7% of the cluster compared to just 38.9% of the survey sample, while 18 to 29 year olds comprise 36.2% of the cluster compared to 40.9% of the total sample. Although this is not inconsistent with the younger demographic lean of the Bitcoin user base, it is noteworthy that those in the second youngest age bracket are better represented within the cluster than the youngest, although there are no implications pertaining to the research questions that stand out.

The more relevant factor is political ideology, with catallactic users possessing a slight skew towards the centre and the centre-left relative to right-of-centre ideologies. For instance, centre-left/liberals represent 23% of the cluster compared to the 21.5% baseline figure, progressives comprise 11.7% of the cluster compared to 10.5% of the baseline figure, socialists comprise 6.4% compared to 5.8% of the baseline figure, and centrists/moderates comprise 16% of the cluster compared to 12.3% of the baseline figure. By contrasts, libertarians are slightly underrepresented at 20.2% of the sample compared to 21.8% and centre-right conservatives are largely underrepresented at 4.3% compared to 8.7% at the baseline level. Although these figures appear small and statistically insignificant, with

the exception of centrists/moderates and conservatives, they become much more noteworthy when compared to pure hedgers.

Of the 86 individuals represented within the pure hedgers cluster, 94.2% are male and 5.8% are female. Concerning their age distribution, 38.4% are aged 18-29, 30.2% are aged 30-39, 23.6% are aged 40-49, 7% are aged 50-59, and 1.2% are aged 60-69. As for their country of residence, 41.9% are from the United States, 12.8% are from the United Kingdom, 10.7% are from Canada, 8.1% are from Australia, 3.5% are from Hong Kong, 2.3% are from Hungary, France, the Netherlands, India, and Taiwan, and 1.2% are from Germany, Italy, Sweden, Russia, Belgium, the Czech Republic, Spain, Uruguay, Brazil, South Africa, and Japan. With respect to their level of education, 8.1% had a high school level or lower, 5.8% had trade, technical, or vocational training, 3.5% had an Associate Degree, 48.8% had a Bachelor's degree, 26.7% had a Master's degree, and 7% had a Doctorate. The occupation of the cluster can be broken down with 7% unemployed, 4.7% in unskilled employment, 11.6% in skilled certificate employment, 51.2% in professional degree-based employment, 18.6% self-employed, 2.3% an executive partner or board member, and 4.7% retired. And finally, the political ideology of the cluster consists of 29% libertarian, 12.8% anarchocapitalist and centre/left liberal, 10.7% centre-right/conservative, 8.1% centrist/moderate, progressive, and apolitical, 7% socialist, 2.3% are anarchocommunists/anarchosyndicalists and 1.2% alt-right.

Much like the catallactic users cluster, the demographic breakdown of pure hedgers is largely consistent with the baseline trend. For instance, gender and country of origin adhere to the male-dominated and Western-oriented lean of the entire survey sample. However, three demographic factors merit particular focus: level of education, occupation, and political ideology. The most notable figure in regard to level of education is that 48.8% of pure hedgers have a Bachelor's degree compared to the 41.7% within the broader survey sample, a factor reflected further by the 51.2% in professional-degree based employed compared to the 43% within the entire respondent pool.

However, although these demographics have greater representation amongst pure hedgers, it is worth noting that those who hold a Bachelor's degree and a professional degree-based field of employment are the largest blocs represented in each category amongst the respondent base as a whole, making these individuals more likely to show up in a demographic breakdown. As such, the statistical relevance of these greater figures amongst pure hedgers is unclear. The more pertinent figure, especially in light of the greater lean to the left amongst catallactic users, is the political ideology of the pure hedgers cluster. Respondents with a right-of-centre ideology appear to be better represented in the pure hedger sample, while left-of-centre individuals are underrepresented. For instance, libertarians comprise 29% of the cluster compared to 21.8% of the total survey sample; anarchocapitalists comprise 12.8% of the cluster compared to 7.9% of the survey sample; and centre-right/conservatives comprise 10.7% of the cluster compared to 8.7% of the sample. By contrast, centre-left/liberals comprise 12.8% of the cluster compared to 21.5% of the total survey sample; progressives represent 8.1% compared to 10.5% of the sample; left anarchists represent 2.3% compared to 2.9%; and even centrists/moderates are underrepresented in the figures, comprising 8.1% of the cluster, compared to 12.3% of the sample. In fact, the only left-wing group to have a higher level of representation is socialists, comprising 7% of the cluster compared to 5.8% of the baseline survey sample.

In determining the underpinning factors which prove influential in determining an individual's assignment to a cluster, the only variable which stands out is political ideology. The gender and nationality demographics of each cluster were within the range of the total survey sample as a whole, age distribution only fluctuated for catallactic users and still maintained a youth-oriented lean, and while pure hedgers were more likely to have a Bachelor's degree and a professional-degree based occupation, these demographics were already dominant within the sample as a whole. The only clear mark of delineation between the two clusters lies in political ideology, with catallactic users having a slight centrist or left-of-centre lean relative to the baseline population, while pure

hedgers have a significant lean towards right-of-centre ideologies. These findings are not inconsistent with the political ideologies themselves and the clusters within which they are overrepresented. After all, right-of-centre ideologies are more likely to be distrusting of governments, central banks, and fiat currencies – especially those that fall under the broad umbrella of libertarianism, which has subsequently led to the stereotype that Bitcoin is a libertarian currency (Karlstrom, 2014).[61] However, as the survey findings demonstrate, there is broad representation of both left-wing and right-wing ideological groups within the user base. As such, while this appears to influence motivations, risk appreciation, and behaviour, no one group comprises a clear majority of the community.

5.7. Overview from the Findings

The findings of the survey reinforce many of those derived from the semantic analysis, including the role of the Bitcoin community and its evolution across a meso trajectory as outlined in section 4.6. When asked whether and how the Bitcoin community was changing, more than half of respondents identified notable changes in the market. Of these changes, the majority pertained to factors that had made Bitcoin safe to use, including upgrades in security software and better awareness amongst users regarding how to hold their cryptocurrency safely, a transition from illicit users to more legitimate ones, and the introduction of KYC/AML legislation to ensure greater legal compliance amongst exchanges and their users. While KYC/AML legislation is an outlier in the sense that such laws are imposed externally via the government, these changes provide a degree of legitimacy as the rest of the Bitcoin market and community evolves along the meso trajectory.

[61] This also suggests that the size of the pure hedge users cluster may be larger than represented in this survey, as ideologically-motivated users are subsequently more likely to belong to this category. However, it is beyond the ability of this analysis to determine that with an acceptable degree of certainty.

The Bitcoin community's decentralised approach also reflects the differing perceptions of internal and external risks, as identified by the semantic analysis. This finding was reinforced by the confidence ranking section of the survey. Across all categories, respondents were substantially more likely to indicate a higher level of concern about external economic risks than internal ones, and distrusted mainstream economic institutions more than those related to Bitcoin. Additionally, in the short answer segment, over a third of respondents were able to point to a specific mainstream economic incident that led to them adopting Bitcoin, while nearly half claimed to use Bitcoin to protect the long-term value of their assets against external risks. Although the research pressed respondents to specify their concerns about the cryptocurrency market, the largest concern of 19% of respondents was government intervention, with the largest remaining groups discussing internal debates that would be addressed by the community itself. Conversely, when asked to outline their primary concerns about the mainstream economy, respondents were more likely to indicate problems outside their power to fix as individuals, such as corporatist corruption, central bank policy, and the prospect of a future economic collapse. These findings are indicative of the emergence of Bitcoin as a result of individuals at the micro level choosing to become de-coordinated from mainstream institutions at the macro level, before re-coordinating in the decentralised cryptocurrency market as it evolves along a meso trajectory.

5.8. Summary

This chapter detailed the findings of a survey which examined the demographics, risk appreciation, motivations, behaviours, and subgroup composition of the Bitcoin community. It is worth reiterating that the responses of the survey sample are indicative of the existence of five behavioural subgroups within the Bitcoin community: catallactic, pure hedge, casual, ideologically-motivated, and profit-motivated users. Furthermore, the main determinant of cluster allocation appears to be political ideology, with right-of-centre users more risk-aversive than their left-of-centre counterparts, who in turn are more practical about government intervention in the cryptocurrency market. This notion of

risk appreciation will be explored further in Chapter 6, which provides an econometric analysis of the relationship between cryptocurrency prices and economic confidence.

6. Econometric Analysis

Throughout the preceding chapters of this thesis, the research has predominantly focused upon analysing Bitcoin and its user base within a social context. Such an approach has favoured the utilisation of user-generated data sets, which Bonneau, et al. (2015) and Morisse (2015) identify as having been neglected throughout the extant body of literature. As such, this chapter represents a marked methodological shift, supplementing this user-oriented approach with an econometric analysis employing more commonly utilised market data. Building upon the case studies provided by Darlington (2014), Ussing, et al. (2014), and Bouoiyour and Selmi (2015), this chapter seeks to determine whether there is evidence of a broader relationship between cryptocurrency prices and confidence. The analysis will be presented in five parts: sections 6.1 through 6.4 will present the findings of stationarity testing, cross-correlation analysis, Johansen cointegration testing, and Granger causality testing, respectively; section 6.5 will tie these findings to the MMM framework; and section 6.6 will summarise the findings of the chapter.

6.1. Stationarity Testing

Before the data can be properly analysed, it must first be adjusted for stationarity in order to correct for any biases or non-stochastic characteristics. In order to determine which time series required transformation in order to achieve stationarity, the data for each variable was input into a correlogram to determine the autocorrelation in each time series over multiple lags. The correlogram results[62] suggest that all data sets are non-stationary and require differencing before they can be employed in this analysis.

[62] In the interests of concise presentation, the correlograms for each variable can be found in Appendix D.

In order to test stationarity, this research will employ the Augmented Dickey-Fuller test. Given that the Augmented Dickey-Fuller test can be expressed in multiple iterations depending on the data being analysed, it is important to address the approach being employed in this research. Firstly, the number of lags are specified automatically in accordance with the Schwarz information selection criterion. Secondly, the regression includes a trend and an intercept, as recommended by Dolado, et al. (1990).

When non-stationarity in the data is determined, the data must be differenced between one period and the next. This process is continued until no unit roots are found, indicating that the transformed data is now stationary (Greene, 2012). The results of the stationarity testing can be found in Table 6.1, which includes the examples of both the original and the differenced data sets. The null hypothesis of the Augmented Dickey-Fuller test is that the series possesses a unit root and is therefore non-stationary.

Table 6.1: Cryptocurrencies and confidence indices ADF test results and lag length probabilities

Time Series	Lag Length	t-Statistic	Probability
Bitcoin Price	2	2.993785	1.0000
Bitcoin Price (First Differenced)	1	-1.421093	0.8477
Bitcoin Price (Second Differenced)	1	-10.04072	0.0000
Ethereum Price	4	-1.14856	0.6750
Ethereum Price (First Differenced)	5	-3.722335	0.0131
OECD Business Confidence	2	-1.473472	0.8311
OECD Business Confidence (First Differenced)	1	-5.496788	0.0001
US Business Confidence	3	-1.982805	0.6018
US Business Confidence (First Differenced)	1	-6.738904	0.0000
OECD Consumer Confidence	0	-2.834553	0.1893
OECD Consumer Confidence (First Differenced)	0	-10.44078	0.0000

Source: Author's estimations derived from ADF testing.

The information derived from the correlograms shows that the original data series are non-stationary. However, as demonstrated in Table 6.1, almost all data sets are stationary following the first differencing of the data. The only exception was the data on Bitcoin prices, which did not

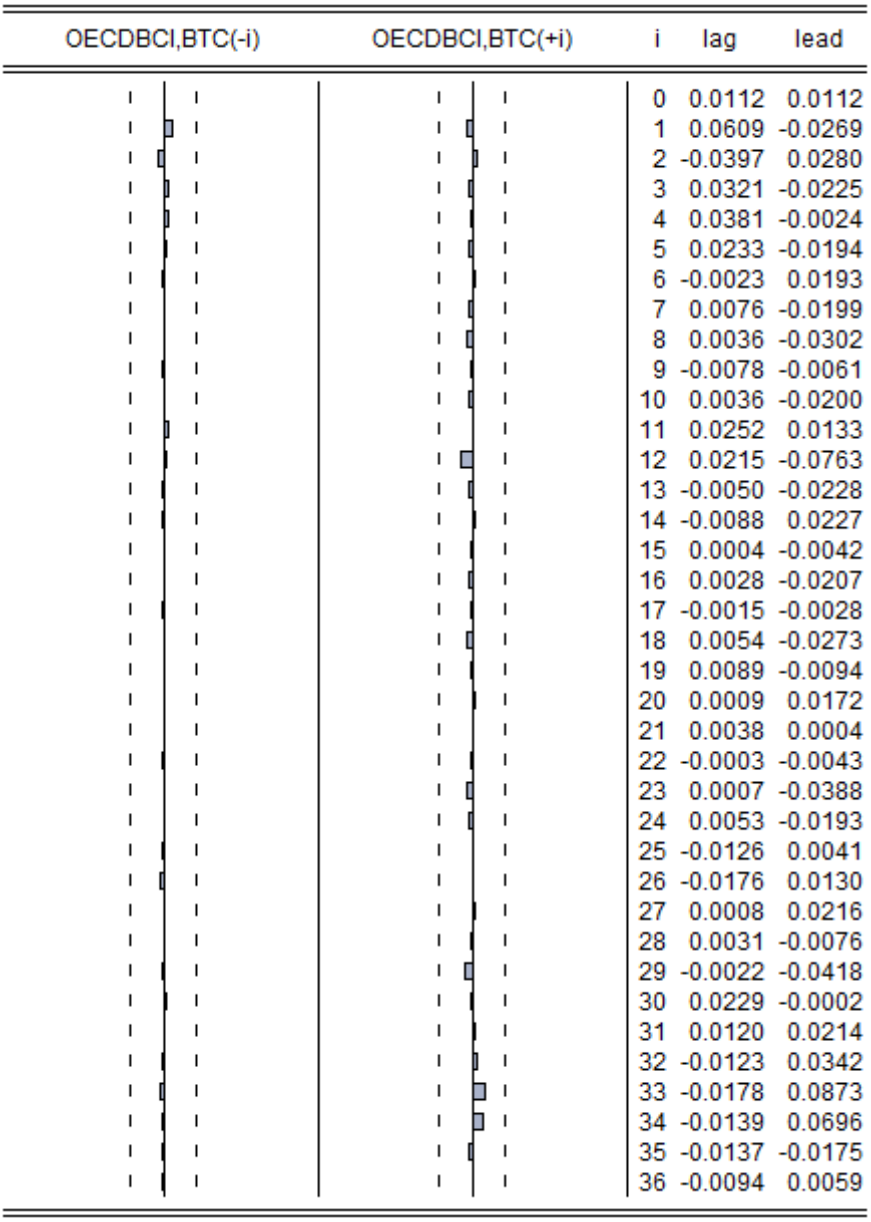
achieve stationarity and subsequently required a second differencing, at which point it became possible to reject the null hypothesis. The behaviour of this price series is most likely reflective of Bitcoin's exponential growth period towards the end of the considered period.

6.2. Cross-Correlation Analysis

After adjusting for stationarity, this analysis will begin by measuring the cross-correlation between Bitcoin prices and the Business Confidence Index for the OECD as a whole. In order to provide an approximation of these trends, the data for both variables was inputted into a correlogram, with a correlation co-efficient calculated across multiple lags. In calculating the cross-correlation between Bitcoin prices and confidence indices, it is possible to measure up to 36 lags, with the results for the first test represented in Figure 6.1.

In analysing the data presented in Figure 6.1, attention should be placed upon the lead values, which determine the extent to which the movements of Bitcoin's value across the time series coincides with that of OECD business confidence. The lag values explore this relationship in the opposite direction, and subsequently merit less attention given that it is unlikely cryptocurrency prices have any impact on broader economic confidence (Seetharaman, et al., 2017). The highest correlation between the two variables can be found at the observation point (t_{33}), which denotes a lead value of -0.0873. This suggests that the coincidence of movements between Bitcoin prices and OECD consumer confidence is weak across the time series.

Figure 6.1: Correlation between Bitcoin prices and OECD business confidence

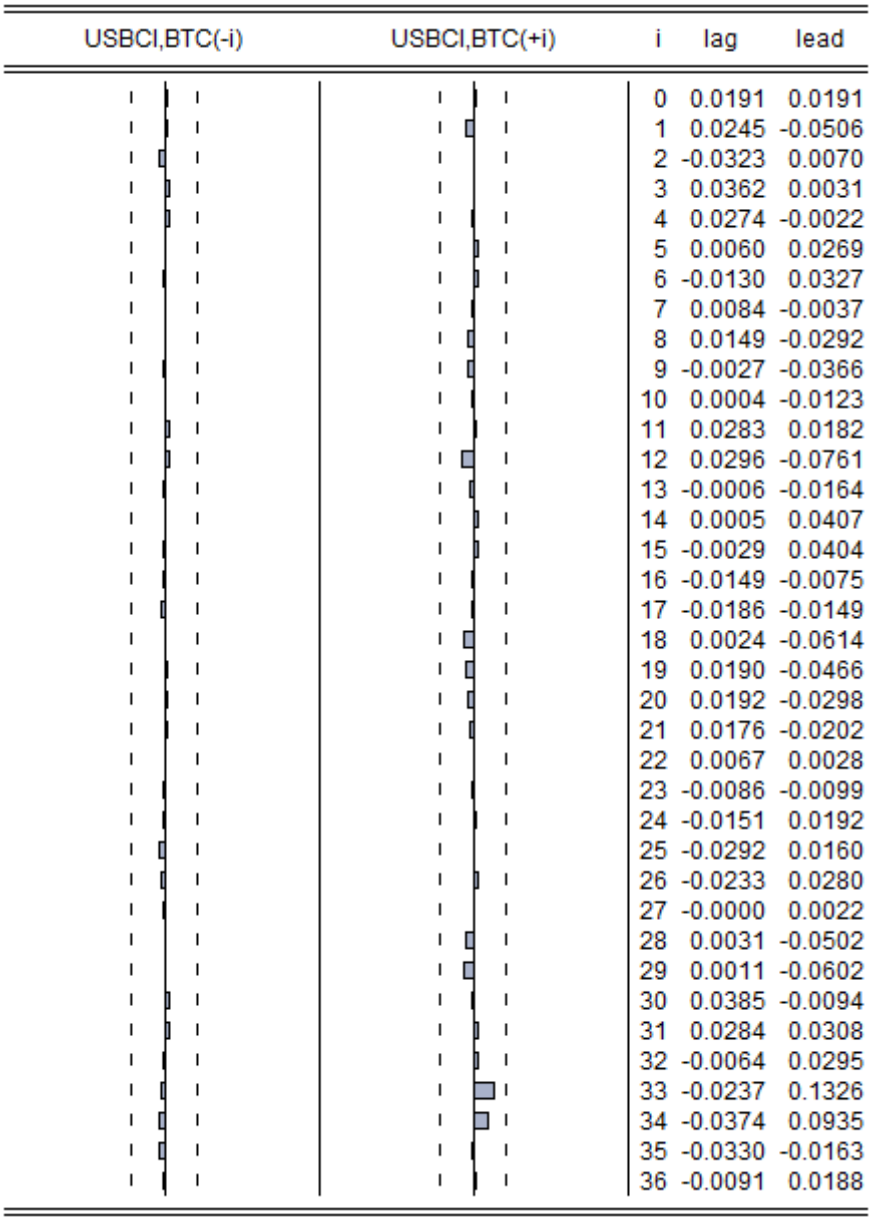


OECDBCI,BTC(-i)	OECDBCI,BTC(+i)	i	lag	lead
		0	0.0112	0.0112
		1	0.0609	-0.0269
		2	-0.0397	0.0280
		3	0.0321	-0.0225
		4	0.0381	-0.0024
		5	0.0233	-0.0194
		6	-0.0023	0.0193
		7	0.0076	-0.0199
		8	0.0036	-0.0302
		9	-0.0078	-0.0061
		10	0.0036	-0.0200
		11	0.0252	0.0133
		12	0.0215	-0.0763
		13	-0.0050	-0.0228
		14	-0.0088	0.0227
		15	0.0004	-0.0042
		16	0.0028	-0.0207
		17	-0.0015	-0.0028
		18	0.0054	-0.0273
		19	0.0089	-0.0094
		20	0.0009	0.0172
		21	0.0038	0.0004
		22	-0.0003	-0.0043
		23	0.0007	-0.0388
		24	0.0053	-0.0193
		25	-0.0126	0.0041
		26	-0.0176	0.0130
		27	0.0008	0.0216
		28	0.0031	-0.0076
		29	-0.0022	-0.0418
		30	0.0229	-0.0002
		31	0.0120	0.0214
		32	-0.0123	0.0342
		33	-0.0178	0.0873
		34	-0.0139	0.0696
		35	-0.0137	-0.0175
		36	-0.0094	0.0059

Source: Author's estimations derived by cross-correlation testing.

While OECD business confidence possesses a very low correlation with Bitcoin prices, this does not necessarily mean that this variable lacks a statistically significant relationship with cryptocurrency prices. To provide an additional metric for analysing the cross-correlation between these variables, this research will turn to business confidence in the United States, with the relationship between the two represented in Figure 6.2.

Figure 6.2: Correlation between Bitcoin prices and US business confidence



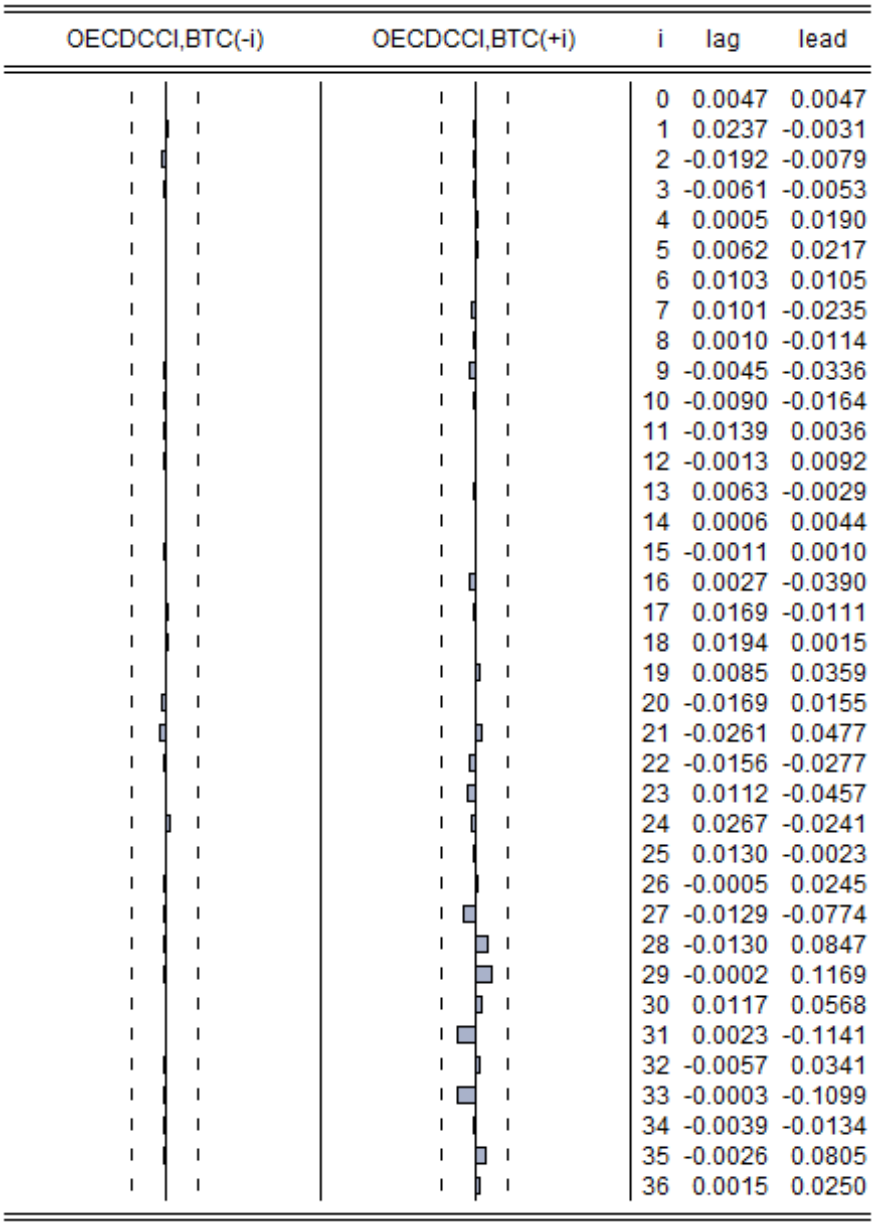
USBCI,BTC(-i)	USBCI,BTC(+i)	i	lag	lead
		0	0.0191	0.0191
		1	0.0245	-0.0506
		2	-0.0323	0.0070
		3	0.0362	0.0031
		4	0.0274	-0.0022
		5	0.0060	0.0269
		6	-0.0130	0.0327
		7	0.0084	-0.0037
		8	0.0149	-0.0292
		9	-0.0027	-0.0366
		10	0.0004	-0.0123
		11	0.0283	0.0182
		12	0.0296	-0.0761
		13	-0.0006	-0.0164
		14	0.0005	0.0407
		15	-0.0029	0.0404
		16	-0.0149	-0.0075
		17	-0.0186	-0.0149
		18	0.0024	-0.0614
		19	0.0190	-0.0466
		20	0.0192	-0.0298
		21	0.0176	-0.0202
		22	0.0067	0.0028
		23	-0.0086	-0.0099
		24	-0.0151	0.0192
		25	-0.0292	0.0160
		26	-0.0233	0.0280
		27	-0.0000	0.0022
		28	0.0031	-0.0502
		29	0.0011	-0.0602
		30	0.0385	-0.0094
		31	0.0284	0.0308
		32	-0.0064	0.0295
		33	-0.0237	0.1326
		34	-0.0374	0.0935
		35	-0.0330	-0.0163
		36	-0.0091	0.0188

Source: Author's estimations derived by cross-correlation testing.

In much the same manner as the Business Confidence Index for the OECD as a whole, the index of business confidence in the United States maintains only a weak relationship with Bitcoin prices across the time series. The highest correlation between the two variables can once again be found at the observation point (t_{33}), which possesses a lead value of 0.1326, indicating no significant co-movement across the time series.

With neither index of business confidence demonstrating a corollary relationship with Bitcoin prices, the analysis will shift to address consumer confidence. The relationship between Bitcoin prices and OECD consumer confidence is depicted in Figure 6.3.

Figure 6.3: Correlation between Bitcoin prices and OECD consumer confidence



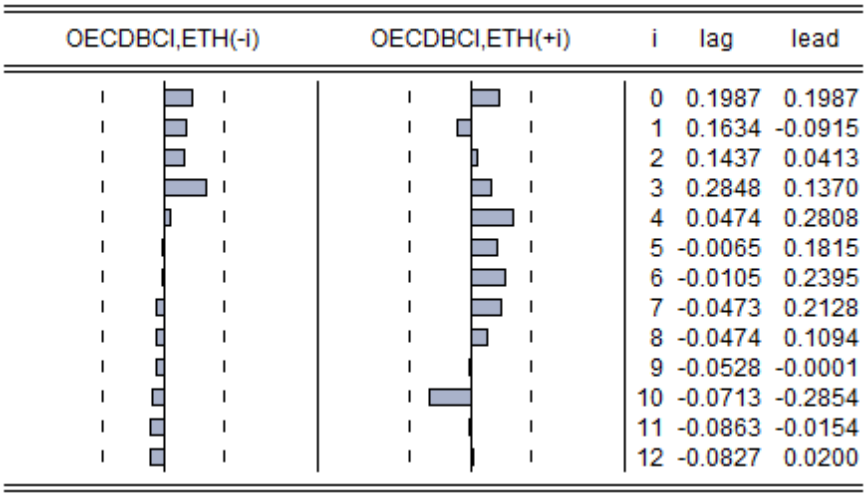
OECDCCI,BTC(-i)	OECDCCI,BTC(+i)	i	lag	lead
		0	0.0047	0.0047
		1	0.0237	-0.0031
		2	-0.0192	-0.0079
		3	-0.0061	-0.0053
		4	0.0005	0.0190
		5	0.0062	0.0217
		6	0.0103	0.0105
		7	0.0101	-0.0235
		8	0.0010	-0.0114
		9	-0.0045	-0.0336
		10	-0.0090	-0.0164
		11	-0.0139	0.0036
		12	-0.0013	0.0092
		13	0.0063	-0.0029
		14	0.0006	0.0044
		15	-0.0011	0.0010
		16	0.0027	-0.0390
		17	0.0169	-0.0111
		18	0.0194	0.0015
		19	0.0085	0.0359
		20	-0.0169	0.0155
		21	-0.0261	0.0477
		22	-0.0156	-0.0277
		23	0.0112	-0.0457
		24	0.0267	-0.0241
		25	0.0130	-0.0023
		26	-0.0005	0.0245
		27	-0.0129	-0.0774
		28	-0.0130	0.0847
		29	-0.0002	0.1169
		30	0.0117	0.0568
		31	0.0023	-0.1141
		32	-0.0057	0.0341
		33	-0.0003	-0.1099
		34	-0.0039	-0.0134
		35	-0.0026	0.0805
		36	0.0015	0.0250

Source: Author's estimations derived by cross-correlation testing.

As shown in Figure 6.3, consumer confidence demonstrates the lowest correlation with Bitcoin among the confidence indices. The highest correlation is identifiable at the observation point (t_{29}), which possesses a lead value of 0.1169. Subsequently, it can be determined that there is no significant coincidence of movement across the time series between Bitcoin prices and any of the confidence variables.

While there were no statistically significant findings employing Bitcoin as a variable, it is nevertheless possible that indices of confidence have an impact on other cryptocurrencies. The other variable that will be employed in this analysis is Ethereum, which has operated for a shorter span of time but has nevertheless become prominent enough in the cryptocurrency market to merit its own analysis. The cross-correlation tests employing Ethereum as a variable produce data for twelve lags, owing to there being less time series data available relative to Bitcoin, with the results comparing it to the Business Confidence Index for the OECD depicted in Figure 6.4.

Figure 6.4: Correlation between Ethereum prices and OECD business confidence

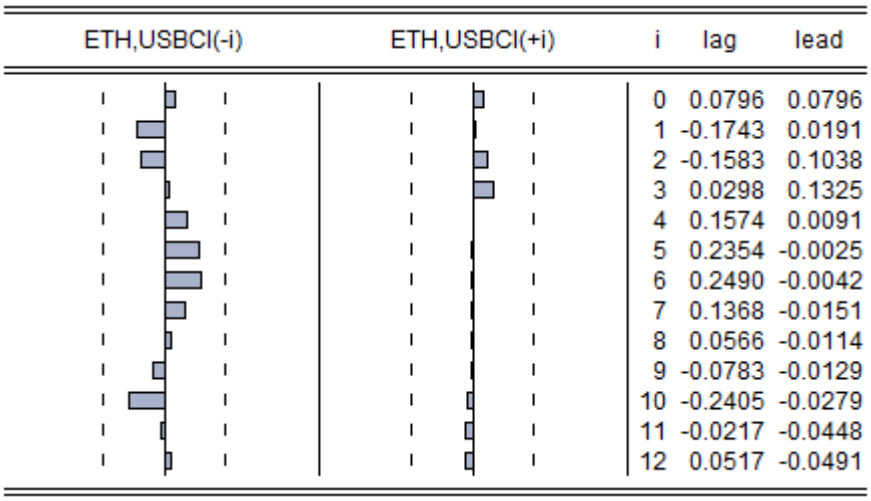


Source: Author's estimations derived by cross-correlation testing.

As indicated by the cross-correlation coefficients in Figure 6.4, Ethereum prices share a stronger relationship with OECD consumer confidence than Bitcoin prices. Moreover, the highest correlation at the observation point (t_{10}) possesses a lead value of -0.2854. Although this is still a relatively weak relationship, it is the strongest identified within this analysis, and suggests that confidence indices may exert greater influence on the value of Ethereum than the dominant cryptocurrency.

Given that Ethereum prices maintain a stronger relationship with OECD consumer confidence than Bitcoin, it is possible that the other variables might follow a similar trend. As such, adjusting the variable of business confidence to represent US data may yield additional insights. The correlation coefficients for Ethereum prices and US business confidence are expressed in Figure 6.5.

Figure 6.5: Correlation between Ethereum prices and US business confidence



i	lag	lead
0	0.0796	0.0796
1	-0.1743	0.0191
2	-0.1583	0.1038
3	0.0298	0.1325
4	0.1574	0.0091
5	0.2354	-0.0025
6	0.2490	-0.0042
7	0.1368	-0.0151
8	0.0566	-0.0114
9	-0.0783	-0.0129
10	-0.2405	-0.0279
11	-0.0217	-0.0448
12	0.0517	-0.0491

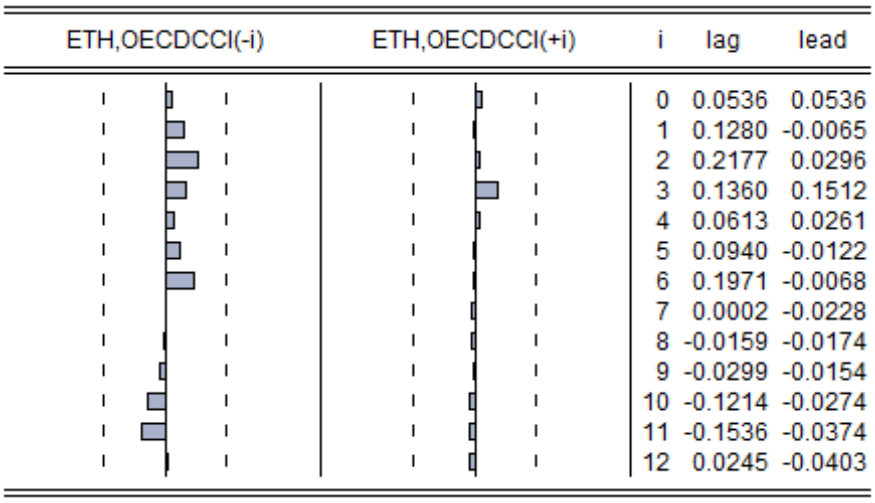
Source: Author's estimations derived by cross-correlation testing.

As indicated by the figures, the relationship between Ethereum prices and US business confidence is once again stronger than that demonstrated when using Bitcoin as a variable. However, it is also weaker than the relationship between Ethereum prices and business confidence in the OECD. The

highest correlation occurs at the observation point (t_3), although this time the lag value is only 0.1325, demonstrating a weak co-movement across the time series.

The final cross-correlation test compares the similarities between Ethereum prices and consumer confidence; the variable that produced the lowest corollary relationship with Bitcoin. These results are presented in Figure 6.6. As evidenced by the trend throughout this cross-correlation analysis, the relationship between Ethereum prices and the OECD Consumer Confidence Index was the weakest amongst the three confidence variables. The highest correlation can be found at the observation point (t_3), which possesses a lead value of only 0.1512. As these low corollary values are consistently demonstrated across all variables, the Johansen cointegration test was employed to provide a deeper analysis of the co-movement between cryptocurrency prices and indices of confidence.

Figure 6.6: Correlation between Ethereum prices and OECD consumer confidence



Source: Author's estimations derived by cross-correlation testing.

6.3. Johansen Cointegration Testing

The analysis begins by determining the level of cointegration between Bitcoin prices and the OECD Business Confidence Index. However, before the Johansen cointegration test can be applied to the

variables, the optimal lag order must be determined. To accomplish this, the vector autoregression (VAR) lag order selection criterion was employed to examine the likelihood ratio (LR) test statistic, the final prediction error (FPE), the Aikake information criterion (AIC), the Schwarz information criterion (SC), and the Hannan-Quinn information criterion (HQ) in order to determine the optimal lag length for inclusion in the test (Lutkepohl, 1991). The VAR lag order test results for Bitcoin prices and the OECD Business Confidence Index are displayed in Table 6.2, with text highlighted in bold denoting the lag length identified by the each particular criterion as optimal for analysis.

Table 6.2: VAR lag order selection criterion for Bitcoin prices and OECD business confidence

Lag	Log Likelihood	LR	FPE	AIC	SC	HQ
0	-645.8762	N/A	56188.06	16.61221	16.67264	16.63640
1	-433.6592	408.1097	269.7872	11.27331	11.45460	11.34588
2	-375.1907	109.4411	66.77184	9.876683	10.17883	9.997636
3	-359.6819	**28.233385**	**49.73962**	**9.581588**	**10.00459**	**9.750922**
4	-357.2623	4.280850	51.85343	9.622110	10.16597	9.839626
5	-356.7552	0.871223	56.80941	9.711671	10.37638	9.977768
6	-355.1371	2.696729	60.53797	9.772747	10.55832	10.08723
7	-353.6820	2.350608	64.84142	9.838000	10.74443	10.20086
8	-349.7552	6.141901	65.25706	9.839877	10.86716	10.25112

Source: Author's calculations derived from VAR lag order selection criterion.

As depicted in Table 6.2, all five tests in the VAR lag order selection criterion indicated that the third lag is optimal for use in the cointegration test. With the optimal lag thus identified, it is possible to accurately employ the Johansen cointegration test on the selected variables, with the null hypothesis that there are no cointegrating equations between the two.

As demonstrated by Table 6.3, it is possible to reject the null hypothesis, with the movements of Bitcoin prices and OECD business confidence over time being cointegrated. However, it must be noted that there is a slight contradiction in the findings, with the trace test indicating that there are two cointegrating equations between the variables while the Max-Eigen test suggests that there are

none. However, both tests are concurrent in the determination that there being a maximum of one cointegrating equation can be rejected.

Table 6.3: Cointegration test results for Bitcoin prices and OECD business confidence

Hypothesised Number of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
None	0.137792	18.54714	15.49471	0.0168
At most 1	0.074967	6.389899	3.841466	0.0155
		Max-Eigen Statistic	**0.05 Critical Value**	**Probability**
		12.15724	14.26460	0.1049
		6.389899	3.841466	0.0155

Source: Author's calculations derived from Johansen cointegration testing.

With the results determining that there is cointegration between the variables, the research is able to employ a vector error correction model (VECM) in order to derive an estimation of the relationship between Bitcoin prices and OECD business confidence. Employing the former as a dependent variable and the latter as an independent variable, the cointegrating relationship between Bitcoin and OECD business confidence can be expressed by the following equation:

$$D(BP) = C(1) * (BP(-1) - 917.960428244 * OECDBCI(-1) + 91{,}559.0001948) + C(2) * D\big(BP(-1)\big) + C(3) * D\big(BP(-2)\big) + C(4) * D\big(BP(-3)\big) + C(5) * D\big(OECDBCI(-1)\big) + C(6) * D\big(OECDBCI(-2)\big) + C(7) * D\big(OECDBCI(-3)\big) + C(8) - - - - - - - - - - - - - - - - - - - Equation\ (6.1)$$

In this equation, *BP* is the dependant variable of Bitcoin prices, *OECDBCI* is the independent variable of the OECD Business Confidence Index, *D* is a difference term, *C*(1) is an error correction term, *C*(2) to *C*(7) are coefficients, and *C*(8) is a constant, as are the numbers which are automatically generated during the test. The equation itself consists of three components, the Johansen long-run equilibrium, and the short-run autoregressive components of the dependent variable and the independent variable respectively. For the purposes of this research, particular attention should be

paid to the long-run equilibrium, which can be derived by normalising the components of the first bracketed equation thusly:

$$BP = -91{,}559.0001948 + 917.960428244 * OECDBCI - - - - - - Equation\ (6.2)$$

The values of *C*(1) through to *C*(8), along with additional relevant information on this equation, are presented in Table 6.4.

Table 6.4: Values of cointegration equation for Bitcoin prices and OECD business confidence

	Coefficient	Standard Error	T-Statistic	Probability
C(1)	0.052041	0.057331	0.907740	0.3670
C(2)	-0.195273	0.134825	-1.448350	0.1517
C(3)	0.661534	0.175411	3.771331	0.0003
C(4)	0.353726	0.207870	1.701680	0.0930
C(5)	-394.7399	528.5873	-0.746783	0.4576
C(6)	765.6327	811.2965	0.943715	0.3484
C(7)	-88.98041	519.5352	-0.171269	0.8645
C(8)	26.66114	22.01574	1.211003	0.2297
R-Squared		0.362870		
F-Statistic		6.020826		
Probability (F-Stat.)		0.000014		

Source: Author's calculations derived from Johansen cointegration testing.

In interpreting the data in Table 6.4, particular attention should be paid to the values of *R*-squared, the probability of the *F*-statistic, and the coefficient of the error correction term *C*(1). Although the probability is well below the 0.05 significance level, indicating that the model is accurate, the value of *R*-squared indications that the level of cointegration between the variables is not particularly significant. Furthermore, as the coefficient of *C*(1) is positive rather than negative, and the probability is not below the 0.05 significance level, it can be determined that the model does not revert back to the long-run equilibrium over time. This is likely a reflection of the fact that Bitcoin prices experience a period of exponential growth towards the end of the time series.

With the cointegrating equation for Bitcoin prices and OECD business confidence thus determined, the research will now analyse the relationship between the former and US business confidence. In

order to do so, the research must first determine the optimal lag length by employing the VAR lag order selection criterion, with the findings presented in Table 6.5.

Table 6.5: VAR lag order selection criterion for Bitcoin prices and US business confidence

Lag	Log Likelihood	LR	FPE	AIC	SC	HQ
0	-677.4751	N/A	126334.5	17.42244	17.48287	17.44663
1	-483.5275	372.9763	969.0425	12.73327	12.73327	12.62456
2	-436.5093	88.00839	321.6791	11.75110	11.75110	11.56991
3	-418.7634	**32.30673**	**226.2658**	**11.09650**	**11.51950**	**11.26583**
4	-416.4948	4.013595	236.7969	11.14089	11.68475	11.35861
5	-416.0046	0.842191	259.5417	11.23089	11.89560	11.49698
6	-415.4897	0.858037	284.5115	11.32025	12.10582	11.63473
7	-413.9858	2.429518	304.3550	11.38425	12.29068	11.74711
8	-408.1478	9.131121	291.6577	11.33712	12.36441	11.74836

Source: Author's calculations derived from VAR lag order selection criterion.

Once again, all five selection criterion indicate that a lag order of three is the most optimal in analysing the variables via cointegration testing. With the optimal lag period identified, the Johansen cointegration test can be applied, with the results for the trace test and Max-Eigen test presented in Table 6.6.

Table 6.6: Cointegration test results for Bitcoin prices and US business confidence

Hypothesised Number of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
None	0.111776	16.16751	15.49471	0.0396
At most 1	0.075621	6.447895	3.841466	0.0111
		Max-Eigen Statistic	**0.05 Critical Value**	**Probability**
		9.719612	14.26460	0.2310
		6.447895	3.841466	0.0111

Source: Author's calculations derived from Johansen cointegration testing.

As was the case in the previous analysis, it is possible to reject the null hypothesis, with Bitcoin prices and US business confidence being cointegrated. However, the results of the trace test and Max-Eigen test are once again contradictory, with the former indicating two cointegrating equations

at the 0.05 significance level and the latter indicating none. Despite these findings, it is possible to determine a cointegrating equation for the two variables.

With a cointegrating relationship identified by the Johansen test, it is again possible to employ a VECM in order to derive an estimation of the level of cointegration between Bitcoin prices and US business confidence. This equation can be expressed thusly:

$$D(BP) = C(1) * (BP(-1) - 503.473688144 * USBCI(-1) + 49{,}986.2650728) + C(2) * D(BP - 1)) + C(3) * D(BP(-2)) + C(4) * D(BP(-3)) + C(5) * D(USBCI(-1)) + C(6) * D(USBCI(-2)) + D(7) * D(USBCI(-3)) + C(8) - \ Equation\ (6.3)$$

The Johansen long-run equilibrium of this model is as follows:

$$BP = -49{,}986.2650728 + 503.473688144 * USBCI - - - - - \ Equation\ (6.4)$$

The values of *C*(1) through to *C*(8) are presented in Table 6.7, along with additional values.

Table 6.7: Values of cointegration equation for Bitcoin prices and US business confidence

	Coefficient	Standard Error	T-Statistic	Probability
C(1)	0.095573	0.060055	1.591438	0.1158
C(2)	-0.266874	0.140330	-1.901759	0.0611
C(3)	0.640708	0.179435	3.570690	0.0006
C(4)	0.260864	0.213352	1.222689	0.2253
C(5)	12.84828	255.3188	0.050323	0.9600
C(6)	-69.59055	369.0784	-0.188552	0.8510
C(7)	242.0553	249.5788	0.969855	0.3363
C(8)	34.98962	22.60415	1.547929	0.1259
R-Squared		0.365497		
F-Statistic		6.089536		
Probability (F-stat.)		0.000012		

Source: Author's calculations derived from Johansen cointegration testing.

In interpreting the results of Table 6.7, the probability value suggests that the model derived via VECM is accurate, but the value of *R*-squared indicates a low level of cointegration between the variables. Furthermore, the coefficient and probability values of *C*(1), which are positive and above

the 0.05 level of significance respectively, indicate that the model once again does not revert back to the long-run equilibrium over time.

With the cointegrating relationship between Bitcoin and the various indices of investor confidence addressed, the study now explores the variable of consumer confidence. Once again, it is necessary to determine the optimal lag length with VAR prior to applying the Johansen cointegration test to the selected variables.

Table 6.8: VAR lag order selection criterion for Bitcoin prices and OECD consumer confidence

Lag	Log Likelihood	LR	FPE	AIC	SC	HQ
0	-694.1344	N/A	193657.9	17.84960	17.91003	17.87379
1	-502.6368	368.2647	1581.755	13.04197	13.22325	13.11454
2	-493.0896	**17.87029**	**1372.421**	**12.89973**	**13.20188**	**13.02069**
3	-489.5141	6.509346	1388.295	12.91062	13.33362	13.07995
4	-488.6653	1.501637	1506.778	12.99142	13.53527	13.20913
5	-487.5012	1.999877	1623.216	13.06413	13.72885	13.33023
6	-487.2133	0.479769	1789.766	13.15932	13.94489	13.47379
7	-485.7082	2.431424	1914.538	13.22329	13.12971	13.58615
8	-484.4443	1.976781	2062.969	13.29344	13.32073	13.70468

Source: Author's calculations derived from VAR lag order selection criterion.

Unlike the previous variables, the tests employed in the VAR lag order selection criterion indicate an optimal lag length of two, although once again all five tests concur in this assessment. With the optimal lag length identified, the Johansen cointegration test can be accurately employed to analyse the relationship between the movements of Bitcoin prices and the OECD Consumer Confidence Index.

As shown by the figures in Table 6.9, it is possible to reject the null hypothesis, as Bitcoin prices and OECD consumer confidence are cointegrated. Moreover, unlike the previous applications of the Johansen cointegration test, both the trace and Max-Eigen tests are concurrent in determining that there is one cointegrating equation at the 0.05 significance level.

Table 6.9: Cointegration test results for Bitcoin prices and OECD consumer confidence

Hypothesised Number of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
None	0.163966	17.12531	15.49471	0.0282
At most 1	0.026875	2.261169	3.841466	0.1327
		Max-Eigen Statistic	**0.05 Critical Value**	**Probability**
		14.86414	14.26460	0.0401
		2.261169	3.841.466	0.1327

Source: Author's calculations derived from Johansen cointegration testing.

With both the trace test and the Max-Eigen test indicating one cointegrating equation between the variables, it is possible to employ a VECM to derive the relationship between Bitcoin prices and OECD consumer confidence, which can be expressed thusly:

$$D(BP) = C(1) * (BP(-1) - 210.002219216 * OECDCCI(-1) + 20{,}544.7256475) + C(2) * D\big(BP(-1)\big) + C(3) * D\big(BP(-2)\big) + C(4) * D\big(OECDCCI(-1)\big) + C(5) * D\big(OECDCCI(-2)\big) + C(6) - - - - - - - - - - - - - Equation\ (6.5)$$

The Johansen long-run equilibrium of this model can be expressed as follows:

$$BP = -20{,}544.7256475 + 210.002219216 * OECDCCI - - - - - - - \ Equation\ (6.6)$$

The values of *C*(1) through to *C*(6) are presented in Table 6.10, along with additional relevant information.

Table 6.10: Values of cointegration equation for Bitcoin prices and OECD consumer confidence

	Coefficient	Standard Error	T-Statistic	Probability
C(1)	0.259720	0.073413	3.537805	0.0007
C(2)	-0.509860	0.170766	-2.985718	0.0038
C(3)	0.455931	0.188765	2.415335	0.0181
C(4)	39.09822	101.6296	0.384713	0.7015
C(5)	14.14431	101.6606	0.139133	0.8897
C(6)	60.33758	22.56900	2.673471	0.0092
R-Squared		0.393966		
F-Statistic		10.01111		
Probability (F-Stat.)		0.000000		

Source: Author's calculations derived from Johansen cointegration testing.

As indicated by the values in Table 6.10, the probability of 0.0000 indicates that the equation derived via VECM is accurate. However, although the value of *R*-squared is the largest among all the applications of a VECM to employ Bitcoin as a variable, the level of cointegration between the two is still low. Finally, although the probability of *C*(1) is below the 0.05 significance level, the positive value of the coefficient indicates that the model does not revert back to the long-run equilibrium over time.

With a cointegrated relationship identified between Bitcoin prices and all three indices of economic confidence, the research will now determine whether such a relationship can also be found with Ethereum. Beginning with the variables of Ethereum prices and the OECD Business Confidence Index, the optimal lag length was determined using the VAR selection criterion, with the results displayed in Table 6.11.

Table 6.11: VAR lag order selection criterion for Ethereum prices and OECD business confidence

Lag	Log Likelihood	LR	FPE	AIC	SC	HQ
0	-122.5684	N/A	881.1727	12.45684	12.55641	12.47628
1	-72.65785	84.84796	8.976340	7.865785	8.164504	7.924098
2	-64.48100	12.26527	6.013439	7.448100	7.945966	7.545288
3	-60.27291	5.470511	6.130719	7.427291	8.124304	7.563355
4	-47.96923	**13.54305**	**2.886283**	6.596923	**7.493082**	**6.771862**
5	-43.94303	3.631680	3.290941	**6.593403**	7.688708	6.807218

Source: Author's calculations derived from VAR lag order selection criterion.

Unlike the preceding variables, the five tests in the VAR lag order selection criterion are not concurrent in identifying the optimal lag length for Ethereum prices and OECD business confidence. Whereas four of the five criterions indicate an optimal lag length of four, the Aikake information criterion suggests five instead. However, given that the majority of criterions employed indicate four, the Johansen cointegration test will be conducted based on the assumption that this is the optimal lag length for analysis.

Table 6.12: Cointegration test results for Ethereum prices and OECD business confidence

Hypothesised Number of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
None	0.358132	10.55407	15.49471	0.2412
At most 1	0.080413	1.676608	3.841466	0.1954
		Max-Eigen Statistic	**0.05 Critical Value**	**Probability**
		8.867458	14.26460	0.2974
		1.676608	3.841466	0.1954

Source: Author's calculations derived from Johansen cointegration testing.

As demonstrated in Table 6.12, the null hypothesis cannot be rejected, with both the trace test and Max-Eigenvalues test indicating values above the 0.05 threshold of statistical significance. As such, it can be determined that the movements of Ethereum prices and the OECD Business Confidence Index are not cointegrated. Since there is no statistically significant relationship between the variables to investigate further, it is neither necessary nor possible to employ VECM in this particular instance.

As there is no cointegrating equation between Ethereum prices and OECD business confidence to derive via the application of a VECM, the research will instead move on to the relationship between the former and US business confidence. Employing VAR, the optimal lag length for inclusion in the Johansen cointegration test was derived, with the results displayed in Table 6.13.

Table 6.13: VAR lag order selection criterion for Ethereum prices and US business confidence

Lag	Log Likelihood	LR	FPE	AIC	SC	HQ
0	-132.4532	N/A	2367.848	13.44532	13.54490	13.46476
1	-94.27161	64.90878	77.94225	10.02716	10.32588	10.08547
2	-82.84135	17.14538	37.71404	9.284235	9.782002	9.381324
3	-73.02313	12.76369	21.94050	8.702313	9.399326	8.838377
4	-56.71321	**17.94091**	6.919670	7.471321	8.367480	7.646251
5	-50.01004	6.032854	**6.042241**	**7.201004**	**8.296309**	**7.414819**

Source: Author's calculations derived from VAR lag order selection criterion.

As was the case during the previous application of the test, the five selection criterions are not concurrent in identifying the optimal lag length for Ethereum prices and US business confidence. This time, the likelihood ratio is the outlying criterion, suggesting an optimal lag length of four, while the other tests indicate an optimal lag length of five. As the latter is indicated by the majority of selection criterion, the Johansen cointegration test will be applied with the assumption of an optimal lag length of five.

Table 6.14: Cointegration test results for Ethereum prices and US business confidence

Hypothesised Number of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
None	0.569975	16.78232	15.49471	0.0318
At most 1	0.038603	0.747982	3.841466	0.3871
		Max-Eigen Statistic	**0.05 Critical Value**	**Probability**
		16.03434	14.26460	0.0260
		0.747982	3.841466	0.3871

Source: Author's calculations derived from Johansen cointegration testing.

As indicated by the results in Table 6.14, it is possible to reject the null hypothesis and determine that the two variables are cointegrated. Moreover, the trace test and Max-Eigen test are both concurrent in the assessment that there is one cointegrating equation between the two variables at the 0.05 significance level.

With both the trace and Max-Eigen tests indicating a cointegrating equation between Ethereum prices and US business confidence, it is possible to employ a VECM in order to derive the following estimate:

$$D(EP) = C(1) * (EP(-1) - 14.910635293 * USBCI(-1) + 1{,}431.93818842) + C(2) * D\big(EP(-1)\big) + C(3) * D\big(EP(-2)\big) + C(4) * D\big(EP(-3)\big) + C(5) * D\big(EP(-4)\big) + C(6) * D\big(EP(-5)\big) + C(7) * D\big(USBCI(-1)\big) + C(8) * D\big(USBCI(-2)\big) + C(9) * D\big(USBCI(-3)\big) + C(10) * D\big(USBCI(-4)\big) + C(11) * D\big(USBCI(-5)\big) + C(12) - - - - - - Equation\ (6.7)$$

The Johansen long-run equilibrium of this model can be expressed thusly:

$$EP = -1{,}431.93818842 + 14.910635293 * USBCI - - - - - - Equation\ (6.8)$$

The values of *C*(1) through to *C*(12) are presented in Table 6.15, along with additional information of relevance.

In assessing the values of Table 6.15, not only is the probability below the 0.05 significance level, but the value of *R*-squared is above 0.9, indicating a high level of cointegration between the two variables. Additionally, the coefficient of the error correction term *C*(1) is negative, with a probability below the 0.05 significance, suggesting that unlike the cointegrating equations for Bitcoin, the model does revert to the long-run equilibrium over time. In essence, any short-run adjustments at which deviations occur due to shocks from one variable to the other correct themselves over time until the long-run relationship is re-established.

Table 6.15: Values of cointegration equation for Ethereum prices and US business confidence

	Coefficient	Standard Error	T-Statistic	Probability
C(1)	-8.398587	3.465357	-2.423585	0.0459
C(2)	8.062083	3.083794	2.614339	0.0347
C(3)	8.157715	3.004150	2.715482	0.0300
C(4)	10.57575	3.244591	3.259500	0.0139
C(5)	3.623946	5.605596	0.646487	0.5386
C(6)	5.425465	4.806174	1.128853	0.2962
C(7)	63.35561	126.9169	0.499190	0.6329
C(8)	-275.3408	150.1377	-1.833921	0.1093
C(9)	-47.38378	191.6949	-0.247183	0.8119
C(10)	-64.82340	209.3662	-0.309617	0.7659
C(11)	-13.19679	120.6400	-0.109390	0.9160
C(12)	-379.1189	158.8693	-2.386357	0.0484
R-Squared		0.931678		
F-Statistic		8.677869		
Probability (F-Stat.)		0.004323		

Source: Author's calculations derived from Johansen cointegration testing.

Finally, this analysis will conclude by measuring the level of cointegration between Ethereum prices and OECD consumer confidence. Prior to running the Johansen cointegration test, the VAR lag order selection criterion was applied to identify the optimal lag length, with the results displayed in Table 6.16.

Table 6.16: VAR lag order selection criterion for Ethereum prices and OECD consumer confidence

Lag	Log Likelihood	LR	FPE	AIC	SC	HQ
0	-108.1024	N/A	207.4017	11.01024	11.10982	11.02968
1	-72.80384	60.00764	9.108349	7.880384	8.179103	7.938697
2	-64.29695	12.76033	5.903777	7.429695	7.927561	7.526884
3	-58.60095	7.404798	5.186797	7.260095	7.957108	7.396160
4	-51.25891	8.076244	4.010590	6.925891	7.822050	7.100831
5	-37.68549	**12.21608**	**1.761772**	**5.968549**	**7.063854**	**6.182364**

Source: Author's calculations derived from VAR lag order selection criterion.

Unlike the preceding applications of the VAR lag order selection criterion to Ethereum prices, all five tests are concurrent in identifying five as the optimal lag length for analysis. As such, the Johansen

cointegration test for Ethereum prices and OECD consumer confidence was conducted with a lag length of five, with the results displayed in Table 6.17.

Table 6.17: Cointegration test results for Ethereum prices and OECD consumer confidence

Hypothesised Number of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
None	0.846307	35.71710	15.49471	0.0000
At most 1	0.007025	0.133946	3.841466	0.7144
		Max-Eigen Statistic	**0.05 Critical Value**	**Probability**
		35.58316	14.26460	0.0000
		0.133946	3.841466	0.7144

Source: Author's calculations derived from Johansen cointegration testing.

As indicated by the findings in Table 6.17, it is possible to reject the null hypothesis of the Johansen test and determine that Ethereum prices and OECD consumer confidence are cointegrated. Additionally, both the trace test and the Max-Eigen test are concurrent in identifying the existence of one cointegrating equation between the two variables at the 0.05 significance level.

Given that both the trace and Max-Eigen tests identified a cointegrating equation between the two variables, it is possible to employ a VECM to derive the following estimate:

$$D(EP) = C(1) * (EP(-1) + 87.2454707612 * OECDCCI(-1) - 8{,}825.32292555) + C(2) * D\big(EP(-1)\big) + C(3) * D\big(EP(-2)\big) + C(4) * D\big(EP(-3)\big) + C(5) * D\big(EP(-4)\big) + C(6) * D\big(EP(-5)\big) + C(7) * D\big(OECDCCI(-1)\big) + C(8) * D\big(OECDCCI(-2)\big) + C(9) * D\big(OECDCCI(-3)\big) + C(10) * D\big(OECDCCI(-4)\big) + C(11) * D(OECDCCI(-5) + C(12) ---------- Equation\ (6.9)$$

The Johansen long-run equilibrium of this model is as follows:

$$EP = 8{,}825.32292555 - 87.2454707612 * OECDCCI ------ Equation\ (6.10)$$

The values of *C*(1) through to *C*(12) are presented, along with additional relevant information, in Table 6.18.

Table 6.18: Values of cointegration equation for Ethereum prices and OECD consumer confidence

	Coefficient	Standard Error	T-Statistic	Probability
C(1)	-6.192229	4.308843	-1.437098	0.1938
C(2)	7.209506	4.537643	1.588822	0.1561
C(3)	8.044854	4.781294	1.682568	0.1363
C(4)	11.24255	5.746022	1.956581	0.0913
C(5)	-2.570695	5.469464	-0.470008	0.6526
C(6)	-1.926784	6.670876	-0.288835	0.7811
C(7)	440.9915	828.7682	0.535334	0.6090
C(8)	1125.496	499.5274	2.253121	0.0589
C(9)	491.0708	695.1259	0.706449	0.5027
C(10)	73.28113	424.8794	0.172475	0.8679
C(11)	550.7721	415.6254	1.325165	0.2267
C(12)	-408.6420	297.3412	-1.374320	0.2117
R-Squared		0.839326		
F-Statistic		3.324226		
Probability (F-Stat.)		0.060903		

Source: Author's calculations derived from Johansen cointegration testing.

Unlike the preceding VECMs employed throughout this analysis, the probability is above the 0.05 significance level, indicating that the model may not in fact be accurate despite the relatively high value of *R*-squared. Moreover, despite a negative value in the coefficient of *C*(1), the probability is also above the 0.05 significance level. As such, although it can be determined that the two variables are cointegrated and revert back to the long-run equilibrium over time, the equation derived through the VECM may not be an accurate representation of this relationship. It is possible that, due to Ethereum's shorter lifespan and consequently fewer data points, the model was unable to express the relationship with an acceptable degree of accuracy. At any rate, the application of Granger causality testing employing in the following section allows for a determination on whether or not the relationship between the two variables can be deemed statistically significant.

Whereas cross-correlation analysis did not determine any relationship between the variables across all six iterations of the data sets, the application of the Johansen cointegration test identified a relationship between the variables in five of the six instances: Bitcoin prices and all indices of economic confidence, as well as Ethereum prices and the US Business Confidence and OECD Consumer Confidence Indexes. This raises the possibility that the value of Bitcoin is influenced in a statistically meaningful way by a number of confidence-related economic factors, while the price of Ethereum is influenced more specifically by the level of business confidence across a number of national economies. However, although the results demonstrate that these variables are cointegrated and that the changes in their values across a time series subsequently move in tandem with one another, this only indicates a corollary relationship without any evidence of the cause of such movements.

6.4. Granger Causality Testing

With cointegration identified between some of the variables, the study now explores the extent to which such co-movements are indicative of a relationship that can be considered significant. To achieve this, the Granger (1969) causality test is used to determine the extent to which the changes in one variable provide relevant information regarding the future direction of another. As has been the case throughout this analysis, the Granger causality test examines the relationship between Bitcoin prices and the Business Confidence Index for the OECD as a whole. Although the Granger causality test is often employed utilising the optimal lag length identified by the VAR lag length selection criterion, the test maximises the number of lags in the interest of a robust analysis. Each test result is presented in a table format with the lag, F-statistic, and probability for that period, with the null hypothesis being that confidence does not Granger cause cryptocurrency price changes. The results for the Granger causality test between OECD business confidence and Bitcoin prices can be found in Table 6.19.

Table 6.19: Granger causality test results for Bitcoin prices and OECD business confidence

Lags	1	2	3	4	5	6	7	8	9
F-Stat.	1.01020	1.36120	0.93229	0.83293	0.91362	0.98448	0.69144	0.65701	0.44570
Prob.	0.3179	0.2625	0.4295	0.5087	0.4776	0.4431	0.6789	0.7266	0.9039
Lags	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
F-Stat.	0.41347	0.75499	1.27447	1.06661	1.03003	0.99850	0.84747	0.70268	0.62397
Prob.	0.9341	0.6815	0.2650	0.4109	0.4447	0.4764	0.6279	0.7772	0.8513
Lags	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
F-Stat.	1.19074	1.16550	1.36544	1.15899	1.06598	0.77698	1.10149	0.81603	0.7232
Prob.	0.3342	0.3592	0.2449	0.3828	0.4634	0.7102	0.4743	0.6745	0.8035

Source: Author's calculations derived from Granger causality testing.

From these results, the null hypothesis is upheld across all lags. The strongest results are found in the 21st lag, which produced an F-statistic of 1.36544. This figure is quite low relative to results that would suggest a causal relationship, with the probability of 0.2449 indicating that this is not significant enough to reject the null hypothesis. As the probability results for all the other lags are even higher than this figure, it can be determined that the null hypothesis can be upheld for all lags and that the Business Confidence Index for the OECD does not Granger cause changes in the price of Bitcoin.

Business confidence does not exert a statistically significant impact on Bitcoin prices. However, at least when applying the index for the OECD as a whole, it is possible that this variable may still produce meaningful results. The Granger causality test results for the impact of US business confidence on Bitcoin price formations is expressed in Table 6.20.

In examining these results, it is evident that the null hypothesis cannot be rejected and that there is no Granger causal relationship between the two variables. The most significant F-statistic comes from the 25th lag, with a score of 2.00530 suggesting the possibility for a weak Granger-causal relationship between the two variables. With a probability of 0.1545, these findings do not meet the threshold necessary for being regarded as statistically significant, and, as such, cannot be cited to

reject the null hypothesis. As a result, it can be determined that indices of business confidence do not possess a statistically meaningful relationship with Bitcoin prices.

Table 6.20: Granger causality test results for Bitcoin prices and the US business confidence

Lags	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
F-Stat.	0.24029	0.34989	0.44207	0.41639	0.36316	0.32229	0.32297	0.28376	0.27914
Prob.	0.6253	0.7059	0.7236	0.7963	0.8720	0.9230	0.9408	0.9688	0.9778
Lags	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
F-Stat.	0.42155	0.85716	1.38811	1.16323	1.27307	1.33020	1.14405	0.97135	0.88798
Prob.	0.9299	0.5861	0.2052	0.3368	0.2649	0.2326	0.3565	0.5096	0.5957
Lags	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
F-Stat.	1.23713	1.55048	1.59404	1.35186	1.25448	1.34544	2.00530	1.96461	1.21326
Prob.	0.3024	0.1553	0.1510	0.2654	0.3363	0.3113	0.1545	0.2332	0.5507

Source: Author's calculations derived from Granger causality testing.

As determined by the findings of the preceding Granger causality tests, indices of business confidence do not have a statistically significant impact on the determination of Bitcoin's prices. As such, the only possible confidence metric remaining among the chosen variables is consumer confidence, as measured across the OECD as a whole. The findings of the unidirectional Granger causality test between these two variables can be found in Table 6.21.

Table 6.21: Granger causality test results for Bitcoin prices and OECD consumer confidence

Lags	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
F-Stat.	0.07205	0.06972	0.05893	0.04018	0.16914	0.34214	0.30627	0.27640	0.31232
Prob.	0.7891	0.9327	0.9811	0.9969	0.9731	0.9120	0.9485	0.9712	0.9677
Lags	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
F-Stat.	0.24811	0.20569	0.37560	0.35919	0.33922	0.30988	0.49590	0.49477	0.52121
Prob.	0.9893	0.9965	0.9659	0.9758	0.9840	0.9912	0.9324	0.9366	0.9246
Lags	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
F-Stat.	0.47985	0.43795	0.44121	0.43014	0.50490	0.37343	0.44331	0.27488	0.54374
Prob.	0.9485	0.9667	0.9652	0.9678	0.9294	0.9789	0.9426	0.9874	0.8217

Source: Author's calculations derived from Granger causality testing.

As was the case in the preceding tests, the null hypothesis for consumer confidence has been upheld. The most significant finding occurred at the 27^{th} lag, which produced an F-statistic of

0.54374 – the lowest result out of all the confidence indexes employed in the Granger causality tests for Bitcoin. This, combined with a probability value of 0.8217, indicates that consumer confidence does not Granger cause changes in Bitcoin's price.

Although none of the chosen confidence variables were shown to Granger-cause changes in Bitcoin prices, it must be noted that Ethereum demonstrated higher levels of cointegration in the data than the dominant cryptocurrency. Therefore, it is possible that Ethereum demonstrates a Granger-causal relationship with confidence indices while Bitcoin does not. Owing to the shorter lifespan of Ethereum, it is only possible to conduct the Granger causality test calculating up to seven lags. The results of the test for Ethereum prices and OECD consumer confidence can be found in Table 6.22.

Table 6.22: Granger causality test results for Ethereum prices and OECD business confidence

Lags	**1**	**2**	**3**	**4**	**5**	**6**	**7**
F-Stat.	0.00196	0.08070	0.65577	3.04019	2.91856	0.91069	2.10507
Prob.	0.9651	0.9228	0.5926	0.0647	0.0863	0.5521	0.3595

Source: Author's calculations derived from Granger causality testing.

The strongest relationship between the variables can be found at the fourth lag, which produced an F-statistic of 3.04019, followed by the fifth lag which demonstrated a similar value of 2.91856. Furthermore, although the probability scores of 0.0647 and 0.0863 respectively are above the 0.05 significance level, they still exist within a range below the 0.09 significance level. Subsequently, it can be determined that the OECD Business Confidence Index does possess a statistically significant influence on cryptocurrency prices at the fourth and fifth lags. However, the F-statistics indicate that such a relationship is weak.

In the previous tests, the variable of US business confidence produced the strongest result in relation to Bitcoin, although none of the results were statistically significant. Combining these results

with the data for Ethereum (which produced stronger results than those derived from the analysis of Bitcoin), makes this particular test the most likely candidate for evidence of a significant relationship. The Granger causality test results for the unidirectional relationship between OECD consumer confidence and Ethereum prices is depicted in Table 6.23.

Table 6.23: Granger causality test results for Ethereum prices and US business confidence

Lags	**1**	**2**	**3**	**4**	**5**	**6**	**7**
F-Stat.	0.47717	0.51656	1.74470	3.57966	2.56973	0.65759	1.161174
Prob.	0.4976	0.6056	0.2038	0.0419	0.1132	0.6899	0.4351

Source: Author's calculations derived from Granger causality testing.

Unlike the preceding Granger causality tests, one of the lag periods produces results that reject the null hypothesis at the 0.05 significance level. On the fourth lag, an F-statistic of 3.57966 was derived, indicating a weak unidirectional Granger causal relationship between OECD consumer confidence and Ethereum prices with a probability value of 0.0419. Although the F-statistic suggests that such a relationship is not particularly strong, the identification of Granger causality between Ethereum prices and OECD business confidence is nevertheless the most significant identified in this analysis.

The final Granger causality test in this analysis involves measuring the relationship between consumer confidence and Ethereum prices. Given the finding of weak Granger causality in the preceding variables, this raises the prospect that other such relationships may be found while employing other variables. However, when the variable of consumer confidence was applied in relationship to Bitcoin prices, it produced the weakest findings compared to the other indices employed in this analysis. The Granger causality test results for Ethereum prices and OECD consumer confidence can be found in Table 6.24.

Table 6.24: Granger causality test results for Ethereum prices and OECD consumer confidence

Lags	1	2	3	4	5	6	7
F-Stat.	0.56399	0.76361	0.66355	0.78719	0.91795	1.53202	1.50096
Prob.	0.4514	0.4813	0.5881	0.5570	0.5154	0.3282	0.4566

Source: Author's calculations derived from Granger causality testing.

Indeed, as was the case in the analysis of Bitcoin, the variable of consumer confidence produced the weakest results in terms of its relationship with Ethereum price formation. The most meaningful result comes from the sixth lag, with an F-statistic of 1.53202 suggesting the possibility of a weak Granger causal relationship between the variables. However, with a probability of 0.3282, these findings do not meet the threshold for being regarded as statistically significant. As such, the null hypothesis is upheld and it can be determined that indices of consumer confidence do not maintain a statistically significant relationship with cryptocurrency prices.

6.5. Overview from the Findings

A number of case studies within the literature demonstrate risk-aversive adoption of Bitcoin in a number of countries, indicating the possibility of a significant relationship between cryptocurrency prices and indices of confidence. The latter variable is indicative of attitudes towards the mainstream economy, with the Bitcoin market providing an alternative in which certain forms of risk are mitigated even as they are replaced with others. Analysis of the time series data indicates that no significant relationship exists between these data sets, with instances of cointegration translating into only a weak Granger causal result or none at all.

Given the broader market focus of the data sets, it is worth exploring these findings at the macro level as Bitcoin evolves along its meso trajectory. The origination phase of Bitcoin coincides with de-coordination at the macro level, with the emergence of cryptocurrency presenting an alternative to mainstream governmental and financial institutions. It seems likely that the risk-aversive adoption

identified by the case studies would occur during this phase for that very reason. However, the volatility of the emerging cryptocurrency market would likely attract speculators and movement traders, which would influence Bitcoin's price independent of those engaged in hedging. As the meso trajectory moves into the adoption phase, re-coordination begins to occur at the macro level as the market grows more sophisticated. This likewise has implications regarding the relationship between Bitcoin's price and confidence, as the growing sophistication of the market and the influx of catallactic and casual users identified in Chapter 5 means that a growing proportion of the user base is not motivated by risk-aversive factors. By contrast, a significant relationship between cryptocurrency prices and confidence would be indicative of a static rather than dynamic user base (i.e. risk-aversive underpinnings would remain an influential determinant of Bitcoin's price even as the market evolves along the meso trajectory). The findings of this study are therefore consistent with those of the previous chapters, with changes to the community and user base at the micro level translating to a more sophisticated market at the macro level as evolution occurs along the meso trajectory.

6.6. Summary

This chapter explored the nature of the relationship between cryptocurrency prices and economy-wide indices of confidence, employing a multi-stage econometric methodology. The preliminary line of inquiry, cross-correlation analysis, was unable to identify any co-movement relationship between any of the data sets at the 0.05 significance level. These findings were contradicted by the results of the Johansen cointegration test, which determined a co-movement relationship between five of the six data sets, with a VECM applied to each to derive models quantifying the cointegrating relationships. However, of the data sets modelled, only one of those employing Bitcoin derived a probability above 0.05. At any rate, the application of Granger causality testing determined that even if cointegration was present in these data sets, the co-movements of each variable across the time series was not driven by any Granger-causal relationship between the two. The exceptions to

this trend were the Granger test results between Ethereum prices and US and OECD business confidence. As such, it can be determined that there is no statistically significant relationship between Bitcoin prices and indices of either consumer or investor confidence, and only a weak relationship between Ethereum prices and business confidence.

With the empirical findings of this thesis now presented, the next chapter consists of a discussion linking the key findings of the semantic analysis, the survey, and the econometric analysis to the framework and the research questions.

7. Discussion

The purpose of this discussion chapter is to relate the findings to the research questions, as per the parameters outlined in section 1.2 of the introduction. In interpreting these findings vis-à-vis the questions, the discussion chapter will employ the micro-meso-macro framework outlined in section 2.6 as an interpretative lens. Finally, despite the interconnectedness of the research questions, each will be addressed in its own section to ensure a structured narrative, with areas of overlap acknowledged as needed. Research questions one through three will be addressed in section 7.1, 7.2, and 7.3, respectively, while section 7.4 will provide a summary.

7.1. Research Question 1

The first question seeks to examine two things: firstly, the extent and nature of Bitcoin's use in hedging; and secondly, the manner in which this behaviour has evolved over time. This question is addressed by employing the semantic analysis and survey data findings. Given their user-derived nature, it is pertinent to first address the role of the Bitcoin community within the MMM framework. Beginning at the micro level, individual Bitcoin users engagement in the process of hedging involves dealing with the fundamental uncertainty inherent in the market by aiming to maintain the value of their portfolio over time. In the origination stage of the meso trajectory, these first adopters experience de-coordination as they move away from more traditional investment assets, institutions, and markets to embrace cryptocurrency. This, in turn, creates the need for social institutions capable of addressing uncertainty and disseminating specialist knowledge of the new marketplace. By the time the meso trajectory reaches its adoption stage, the Bitcoin community has emerged in online spaces to address this need. In this context, the community emerges as a knowledge commons where information is shared as a pooled resource, or as a market for preferences, where perceived experts disseminate specialist knowledge about low-level

preferences.[63] This is evident from the findings of the semantic analysis, which flagged the primary forms of risk being discussed by the community. While it is demonstrable that internal economic risks generated more discussion traffic than external ones, this could be reflective of members of the community being perceived to have expertise in the former but not the latter within the context of a market for preferences. However, a risk-averse mentality is at least somewhat evident as per the discussion traffic regarding gold, with threads dedicated to comparing the role of Bitcoin and gold as a hedge against government and central bank failures.[64]

Prevalence of discussion on internal rather than external economic risks is clear, but the rationale is unclear as to whether it is symptomatic of a greater focus among users or the community providing a market for preferences specifically focused on cryptocurrency. Attitudinal differences to the two forms of risk are identifiable. While external risks are treated like hazards to be avoided via the use of Bitcoin, internal risks are regarded as problems to be solved. This is especially evident in the adoption stage of the meso trajectory, as social institutions form to address problems (discussed in section 7.2). This difference in risk appreciation is reflected in the confidence rankings section of the survey. Across all categories, respondents were substantially more likely to indicate a higher level of concern about external economic risks than internal ones, and distrusted mainstream economic institutions more than those related to Bitcoin. Pure hedgers and ideologically-motivated users in particular were distrustful of mainstream institutions, regarding them as threats to their freedom and security instead of being necessary for maintaining stability within the market. Conversely, catallactic users tended to lack such anti-institutional biases and were motivated by more practical concerns. Additionally, in the short answer segment, 39.1% of respondents were able to point to a

[63] It should be noted that these two concepts are not mutually exclusive. After all, as noted by Earl and Potts (2004), the market for preferences emerges to satisfy the demand for information pertaining to low-level preferences. High-level preferences may better be addressed within the knowledge commons, or, as will be discussed later in this chapter, innovation commons.

[64] Refer to the semantic analysis of discussion traffic on "gold" in Section 4.4 for specific threads and their titles.

specific mainstream economic incident that led to them adopting Bitcoin, while 47.2% claimed to use Bitcoin to protect the long-term value of their assets against external risks. Although the research pressed respondents to specify their concerns about the cryptocurrency market, the largest concern of 19% of respondents was government intervention, with the largest remaining groups discussing internal debates which would be addressed by the community itself. Conversely, when asked to outline their primary concerns about the mainstream economy, respondents were more likely to indicate problems outside their power to fix as individuals, such as corporatist corruption, central bank policy, and the prospect of a future economic collapse. These findings speak to the role that risk aversion and subjective risk appreciation, particularly in regard to the mainstream economy and its institutions, influences the adoption of Bitcoin.

Although the research identifies risk-averse motivations underpinning Bitcoin adoption, this is not reflected within the overall usage. Instead, the Bitcoin market is growing more sophisticated at the macro level and this is reflected in the diverse array of user behaviour at the micro level. As noted by the cluster analysis in Chapter 5, the community can be described as adhering to five behavioural archetypal clusters of users: catallactic (33.3%), pure hedgers (30.5%), casual (17.4%), ideologically-driven (9.6%), and profit-driven (9.2%). Even factoring in the overlap between categories, the extent to which Bitcoin is employed as a hedge remains limited. Instead, a plurality of users are catallactic in their behaviour, and while casual users need to be considered in the context of this discussion, the reference to catallaxy is important. As Bitcoin has entered into the adoption phase of the meso trajectory, the market has grown more sophisticated and the re-coordination at the macro level has seen evolution in the market driven by the emergence of institutional entrepreneurs (Teigland, et al., 2013; Tasca, et al., 2018). While this will be addressed more in Section 7.2, it can be determined that hedging is only limited in scope in the Bitcoin community. Case studies of Cyprus, Greece, and Argentina demonstrate abnormal circumstances that drove the adoption of Bitcoin as a hedge in a specific period of crisis. Argentina is especially indicative of this niche function, as capital controls

imposed by the government had the unintended consequence of making Bitcoin the next best alternative to hedge against inflation (Ussing, et al., 2014). Furthermore, while the community is the focus of this research, it can be assumed that this means that hedging is for specific limited reasons. Thus, hedging is less prevalent when factoring in the broader user base, with speculators less likely to be represented amongst the collected data. Overall, hedging appears to be a result of the transition along the meso trajectory from origination to adoption, with the growth in the market appealing to a wider variety of users.

In rejecting the notion of Bitcoin serving as a hedge outside of niche circumstances, it is worth revisiting the financial instability hypothesis, which examines the transition from hedging to speculative and Ponzi units of finance (Minsky, 1992). As Minsky notes, the continued pursuit of profits leads to a transition from stable to unstable units of finance, which necessitates a corrective influence from institutions such as central banks. This profit-motivated transition is pertinent, not just because of the lack of such institutions, but also because the 'movement trader' conceptualisation of speculators is useful for explaining this transition. As noted by Irwin (1937), movement traders lack any particular form of attachment to the assets that they invest in and instead tend to follow market signals indicating short-term profitability. The CoinDesk (2017a) price data employed by this research demonstrates that the price of Bitcoin is prone to high levels of fluctuation on a day-to-day basis, which would be attractive from a movement traders' perspective, with this volatility translating into boom-and-bust cycles reminiscent of Minsky's (1992) financial instability hypothesis. This transition from stable hedging to speculative and Ponzi finance units undermines the application of Bitcoin as a viable currency alternative as the market evolves, especially as early adopters with risk-averse motivations are joined by a growing share of speculation-oriented movement traders.

Investors engaged in hedging are more concerned with minimising the impacts of uncertainty within the market, as per the Cox, et al. (1979) binomial option pricing model. While the findings of this thesis reject the notion that Bitcoin is being employed as a hedge to a significant extent within the community, the cluster analysis of Chapter 5 identifies 'pure hedgers' as a sizeable minority group.[65] Given that binomial option pricing seeks to deal with uncertainty by adjusting the amount of assets held in the portfolio over time, Bitcoin seems a poor fit relative to other alternatives in the absence of unseen variables. After all, fiat currencies are inherently more stable than cryptocurrency – at least under what might be considered 'normal' economic circumstances – and this issue is further compounded when one expands the Cox, et al. (1979) formula to incorporate more traditional hedges into the portfolio. This would suggest that Bitcoin would appeal more to movement traders, driving the transition from hedging to speculative finance as outlined by Minsky (1992).

Nevertheless, in presenting the Cox, et al. (1979) model, it was noted that there were likely extraneous variables at play that counterbalanced the volatility of Bitcoin, and it is worth considering that in the context of the MMM framework. In particular, the de-coordination and re-coordination occurring at the macro level over the course of Bitcoin's evolution is reflective of the emergence of new social institutions through which risk is addressed. As per Figure 5.10, the three risks that users are most concerned about are levels of government debt, the prospect of a coming recession or depression, and inflation. Furthermore, as per Figure 5.11, all institutions pertaining to the mainstream economy are distrusted by a majority of the respondent pool, and while there seems to be an overarching trend of anti-institutionalism, those embedded within the cryptocurrency market have higher ratings of trust or indifference compared to mainstream institutions.[66] This would appear to indicate that the unseen variables that influence the use of Bitcoin as a hedge are based

[65] It is also worth considering ideologically-motivated users within the context of this discussion, although the thesis derived less information on this grouping.

[66] These broad strokes trends have been cited for the sake of concise discussion. However, they are also reinforced and discussed in greater depth in the short answer responses detailed in Section 5.4.

on high levels of sensitivity to risk produced by governments and central banks, along with high levels of distrust in mainstream economic institutions. However, the cluster analysis demonstrates that only 30.5% of the Bitcoin community can be said to be consistently motivated by a desire to use Bitcoin in hedging. It should be noted that Bitcoin cannot be said to have reached the meso trajectory of the MMM framework, but its evolutionary trend has been towards increasing market sophistication (Tasca, et al., 2018). As such, the future viability as an instrument of hedging may be dependent on the motivations and behaviours of new entrants to the market, and whether they are movement traders drawn by price volatility or catallactic and casual users attracted by growing commercial activity and acceptance.

7.2. Research Question 2

The second research question of this thesis seeks to identify how individual Bitcoin users perceive their own motivations, uses, and the risks driving their behaviour over the course of Bitcoin's evolution. Due to the overlap in the research questions, elements of this have been partially addressed in section 7.1. For instance, it is worth bearing in mind the attitudinal differences between internal and external risks, and the cluster composition of users in the Bitcoin community. The evolutionary focus of this question means that the MMM framework applied to the Bitcoin community in section 7.1 is also still applicable, except that the theories related to hedging can be replaced by those with a broader economic focus.

One of the main findings of the semantic analysis was that the majority of the Bitcoin community is more concerned with longer-term investments than they are with short-term profit-making via speculation. This was determined by an initial analysis of topics pertaining to different types of investment activity, which revealed interest in speculation and volatility was low both in the general sense and relative to longer-term activities such as investment. A deeper analysis of the

conversational context surrounding those discussions confirmed this initial finding. This was further corroborated by the survey, with the confidence ranking section identifying the ability to derive a profit from long-term investment as the most important factor amongst the respondents, while the ability to derive profits from mining Bitcoin or speculation ranked amongst the lowest. A breakdown of respondents into subgroups via cluster analysis found that catallactic users, which included those engaged in long-term investment activity, was the largest group, while profit-motivated users were the smallest. From this analysis, the interpretation of the Bitcoin community within the MMM framework applies, with online forums functioning as a knowledge commons and market for preferences at the micro level, with greater economic sophistication occurring at the macro level. However, a deeper understanding of this evolutionary process along the meso trajectory is necessary for addressing this research question.

Beginning at the micro-level, semantic analysis showed evidence of the Bitcoin economy evolving over time, with a growing trend towards more legitimate uses of cryptocurrency and decentralised methods of combatting risks. Change in the nature of conversations and topics evolved during peaks of discussion in the later years of the forum's existence relative to discussions on the same topics during earlier years. This evolving pattern of learning at the micro-level is reflected in the survey, with 58.1% observing a notable change in the Bitcoin market over time, compared to just 27.6% who said no changes had occurred and 14.3% who claimed to be uncertain. Of these changes, the majority pertained to factors that had made Bitcoin safe to use, with 19.7% citing upgrades in security software and better awareness amongst users regarding how to hold their cryptocurrency safely, 14.6% citing a transition from illicit users to more legitimate ones, and 7.1% citing the introduction of KYC/AML legislation to ensure greater legal compliance amongst exchanges and their users. This learning pattern is corroborated by both stages of the analysis, and also by Tasca, et al. (2018). Thus, it is possible to say with a high level of confidence that there is an evolving pattern of learning at the micro-level with the adoption of Bitcoin.

The evolution of the Bitcoin market has occurred at the community level through the emergence of social institutions and institutional entrepreneurship. The only exception is the establishment of KYC/AML legislation, but this provides external legitimacy to internal evolution, and is an essential aspect of all major structural shifts in innovation. Community-level market development indicates that the MMM interpretation of the Bitcoin community needs to be expanded. Whereas the analysis thus far has focused on the community as a knowledge commons at the micro level, the application of this common pool information to the formation of new ideas is more reminiscent of an innovation commons (Ostrom, 1990; Allen and Potts, 2016). For example, the semantic analysis identified the emergence of community watchdogs as a means of looking out for scams, and ratings agencies that assess the trustworthiness of Bitcoin mining pools, wallet providers, and other Bitcoin-related institutions. These examples of emergent institutional entrepreneurship were similarly identified in the research of Teigland, et al. (2013).

It is worth drawing a distinction between internal attempts at legitimisation (those driven by institutional entrepreneurs) and external efforts to achieve the same (legislation imposed by governments). The former of these is consistent with Hayek's (1977) notion of catallaxy, while the need for the latter is a rejection of such a concept and the free market principles that underpin it. This distinction is central to the ideological divergence between the hedge user and catallactic user clusters of the community, as demonstrated by the former's opposition to government intervention (and perception that this poses a threat to the market) and the latter's more open-minded attitude to such interventions. Assessment of the motivations of Bitcoin users must acknowledge these differing attitudes between members of the community. As Bitcoin attempts to move towards the retention phase of the meso trajectory, the composition of the community may change based on whether, and how, government regulations are further imposed on the cryptocurrency market. For

example, the most privacy-conscious survey respondents indicated a preference for Monero, an altcoin designed with greater privacy protections for users as a central focus.

In the context of the MMM framework, it is noteworthy that institutional entrepreneurs were only identified in the latter half of the Bitcoin community's existence. In the first half, or the origination stage of the meso trajectory, discussion traffic pertaining to risks mostly focused on the harm caused by internal problems. The self-organisational approach to problem solving only occurred during the adoption phase along this trajectory. This in turn ties into the growing sophistication of the cryptocurrency marketplace at the macro level, with the re-coordination of economic actors and social institutions resulting in a catallaxy underpinned by the innovation-producing blockchain technology that forms the basis of institutional cryptoeconomics (MacDonald, et al., 2016; Davidson, et al., 2018; Allen, et al., 2019). However, the meso trajectory has yet to move on to its retention phase and these social institutions remain dynamic, as per the emerging evolutionary trajectory identified by Tasca, et al. (2018).

The manner in which the Bitcoin community addresses problems in turn leads to the different conceptualisations of risk raised in section 7.1. In terms of their risk appreciation, the Bitcoin community appears to regard external risks as threats to be mitigated and internal risks as problems to be solved. Only the latter can be engaged through the market for preferences or the market-oriented approach to problem-solving provided by the innovations common. At the very least, this differentiation between different forms of risk has also resulted in behavioural differences as denoted by the emergence of community groups.

Not all members of the Bitcoin community are so risk-averse when it comes to the mainstream economy. As demonstrated by the breakdown of clusters presented in section 5.6, pure hedgers and ideologically-motivated users were the groups most likely to hold risk-averse motivations for the adoption and use of cryptocurrency. Catallactic users, casual users, and profit-driven users were less likely to hold negative views regarding the mainstream economy or its institutions, and tended to employ Bitcoin in diverse ways as needed. A comparison of these results to the demographic compositions of each cluster identified political ideology as the sole significant factor, with those holding right-of-centre views overrepresented among pure hedgers and those holding left-of-centre views overrepresented among catallactic users. The limitations in terms of sample size prevented the other clusters from being subjected to the same level of analysis. Moreover, although this research has focused upon the Bitcoin community rather than the user base as a whole, it must be acknowledged that no such line of demarcation exists within the market itself and the latter impacts upon the former; for example, the hedging motivations of a portion of the community are not insulated from the speculation engaged in by movement traders (Irwin, 1937). Even in light of these considerations, the MMM framework demonstrates how these diverse actors shape the evolution of the cryptocurrency market and community through their specific motivations, uses, and appreciations of risk.

7.3. Research Question 3

The third research question seeks to determine the nature of the relationship between cryptocurrency prices and consumer and investor confidence indices. Econometric analysis of the variables was carried out in Chapter 6, with the empirical findings therein being of greatest relevance to the discussion. However, given the interconnected nature of the research questions, it is worth noting that the research findings addressed in sections 7.1 and 7.2 have implications regarding the relationship between the variables in this econometric analysis. After all, the notion

that indices of confidence, whether from investors or consumers, may impact on the value of cryptocurrency is inherently tied to the notion that Bitcoin adoption is a risk-averse act. This is demonstrated by Darlington (2014), Ussing, et al. (2014) and Bouoiyour and Selmi (2015), although the thesis eschewed expanding on their national and regional focus in lieu of exploring global trends. However, as outlined in sections 7.1 and 7.2, the empirical findings of this thesis do not support the supposition that the adoption and usage of Bitcoin is inherently risk-averse. Moreover, there appears to be a distinction between why individuals adopt Bitcoin and how they use it in at least some instances. Adoption by the Bitcoin community relates to risk-averse motivations. Yet, these same cluster groups do get involved in a significant degree of voluntary risk-taking. In this context, the notion that there may be a significant relationship between cryptocurrency prices and confidence seems less likely than might be inferred from the case studies and other literature given the risk-taking behaviour that follows adoption.

The econometric analyses in Chapter 6 did not evidence statistical significance between consumer and investor confidence and cryptocurrency prices. The analysis showed the identification of co-movement between the variables, but there was not a statistically significant Granger causality. The exceptions to these results were the Granger causality between Ethereum prices and US and OECD business confidence. In interpreting these findings, it is worth noting that the data sets employed in Chapter 6 focused on the user base as a whole, rather than the community that comprises the focus of this research. Indeed, the volatility in Bitcoin prices is likely to both attract and be driven by movement traders who are unlikely to possess any community ties to Bitcoin (Irwin, 1937). For this reason, it is worth contextualising the econometric analysis with the forum and survey data to interpret how the findings relate to the community.

Both the semantic analysis and the survey demonstrate that the Bitcoin community is largely uninterested in deriving a profit through speculation, instead focusing on longer-term forms of investment. Cluster analysis indicates that pure hedgers and ideologically-motivated users make about 40% of the community, and this large minority are distrustful of mainstream economic institutions. It stands to reason that the decision of this large minority of individuals to adopt Bitcoin is influenced to a significant degree by their relatively low levels of confidence in the mainstream economy. While this anti-institutional attitude is most prevalent within these clusters, it is also broadly reflected within the community as a whole. For instance, no mainstream economic institution received the trust of even half of respondents; only 14.6% claimed to have no concerns about the mainstream economy, compared the 16.3% concerned about debt, 15.3% worried about inflation, 13.6% believing that mainstream institutions were corrupt, and 7.1% convinced an economic collapse is imminent; and 47.2% of respondents claim to have used Bitcoin to protect their wealth from a perceived threat.

While the survey findings are indicative of a large section of the community that is risk averse (i.e. motivated by low levels of confidence in the mainstream economy), the cluster analysis demonstrates that this group is still a minority and approximately matched in size by catallactic users. Furthermore, there is no line of demarcation between the community and the rest of the user base when it comes to determining the price of Bitcoin, as demonstrated by the discussion on the role of speculators in driving the business cycle detailed in section 7.2. The evolutionary pathway presented through the application of the MMM framework is useful for contextualising this point. In the origination phase of the meso trajectory, the Bitcoin community begins to emerge as a market for preferences in which these risk-averse notions were presented, for example, through forums identified by the semantic analysis treating external risks as hazards to be avoided through the use of Bitcoin. However, by the time the meso trajectory moved on to the adoption phase, the community further evolved and re-coordinated as a commons for both knowledge and innovation.

This proactive approach to problem-solving is reflective of a broader subset of users within the community interested in more than just hedging via Bitcoin. Just as the discussion in section 7.1 determined that Bitcoin is not ideally suited to serve as a hedge outside of niche circumstances, it can be further inferred that a minority of users within the community motivated by risk-aversion does not translate into a statistically significant relationship between Bitcoin prices and confidence.

The research landscape changes swiftly in regard to cryptocurrency. A number of developments regarding the price of Bitcoin occurred since the compilation of the price and confidence indices data in the study. The cut-off point for the data was September of 2017. As per Coindesk's (2017a) Bitcoin Price Index, the closing value for the cryptocurrency at the end of that month was at USD$4,353.05. Three months later, by late December, the value of a single Bitcoin had surpassed USD$19,000 for the first time, representing a more than fourfold increase in its value while this research was being conducted. Additionally, the market capitalisation of the entire cryptocurrency market (including altcoins) surpassed USD$200 billion for the first time at the start of November, and then over $300 billion by month's end, constituting a 750% increase from its USD$40 billion market capitalisation at the beginning of 2017 (CoinMarketCap, 2020). However, by February, the price of Bitcoin had fallen to USD$6,914.26. By contrast, the OECD's (2017a; 2017b) leading indicators demonstrate that while both consumer and investor confidence have risen slightly over the same two-month period, their values continue to exist within the narrow range as was found throughout this research. This pattern has remained consistent into August 2019, with Bitcoin prices demonstrating large fluctuations and confidence moving along the same narrow, unrelated range (CoinMarketCap, 2020). This seems to reinforce the findings of this study that there is not a statistically significant relationship between the chosen variables.

The findings of Chapter 6 make it difficult to offer any insights into the booms-and-busts that occurred after data analysis that are empirically-based, as opposed to extrapolation based on theory. It should be noted that some cryptocurrency analysts attribute the exponential increase in Bitcoin's value to the events surrounding that year's Cyber Monday, the online retailer equivalent of the United States' Thanksgiving holiday sales (Martin, 2017; Sedgwick, 2017). Given that Bitcoin offers a number of advantages over other payment methods in online transactions, cryptocurrency businesses such as exchanges attempted to capitalise on Cyber Monday sales by marketing themselves directly to customers. For example, the Bitcoin financial services provider Bitconnect offered a 3%-5% cashback offer for new investors on Cyber Monday in an attempt to draw in new customers made aware of the cryptocurrency during the online sales period (Shashank, 2017). Similarly, the Bitcoin wallet provider Wirex (2017) ran a competition offering free Bitcoins to any customers capable of referring the most new users to their service over the Black Friday and Cyber Monday sales period. These marketing strategies appear to have been successful in capitalising on the increased interest in Bitcoin to attract new customers, with Forex Analysis (2017) observing that over the 24-hour period on Black Friday, over USD$5.1 billion worth of Bitcoins were traded before the close of the day. Moreover, a relatively stable exchange price of USD$8,200 over the course of that period indicates that the bulk of these transactions were not coming from trading on the exchanges, but rather commercial activities (Forex, 2017).

Despite these significant findings, this exponential growth period for Bitcoin cannot be purely attributed to the sales period over that year's American Thanksgiving holiday. Indeed, as Schleifer and Molla (2017) have noted, this boom period in commercial sales also happened to coincide with an influx of capital into cryptocurrency investments driven by growing interest from mainstream institutions such as venture capital firms. This may be pertinent, as data from CoinMarketCap (2020) demonstrates that the boom-and-bust cycle over the Thanksgiving holiday period was not repeated in 2018 and 2019. The 2018 holiday period occurred during the middle of a consistent downwards

trend in Bitcoin's price and did not alter its trajectory in any significant way. The 2019 period coincided with price fluctuations, but these were not outside the range of Bitcoin's price in the preceding and following months, and did not resemble the 2017 boom-and-bust period. Given the context of this research, it must be noted that there is no data to demonstrate that the growing commercial adoption of Bitcoin was a statistically significant driver of Bitcoin's value in these instance.

The increasing integration of Bitcoin into Black Friday and Cyber Monday sales is consistent with the evolutionary research into Bitcoin, both in terms of this thesis' interpretation of the empirical findings within the MMM framework and the research of Tasca, et al. (2018). Nevertheless, it is worth noting that the user base drives the price movements of Bitcoin as opposed to only the Bitcoin community, which makes it worth revisiting Minsky. After all, while the research has determined that the community is less motivated by speculation and is collectively self-organising to counter such issues as Ponzi financing, Mazzucato (2018) notes that this kind of financial self-regulation has never been able to counter the negative impacts of self-motivated actors in all its forms. In other words, greed and corruption in the financial sphere can only be self-regulated or self-controlled to the extent that cultural or community factors rein in bad actors, but this does not change the underlying institutional factors that arise due to self-interest. The financial instability hypothesis of Minsky (1992) addresses the manner in which hedge financing units transition into speculative and the Ponzi units to create a boom and bust period. It is difficult to argue that the period in which Bitcoin's price rose from over USD$4,000 to almost USD$20,000, only to fall below USD$7,000 in the span of a few months could be caused by anything other than speculation, perhaps bolstered by increasing media attention of Bitcoin's price volatility. Moreover, Ponzi activity can be identified within the cryptocurrency market, as outlined by Teigland, et al. (2013) and the discussion of conversation traffic on internal risks in Section 4.3 of this thesis.

In applying Minsky's instability theory to address the boom-and-bust cycle of Bitcoin, attention should also be given to his work on the five stages of a bubble: displacement, boom, euphoria, profit-taking, and panic. The first stage occurs as investors rush to embrace a new technology, in this case Bitcoin, with the increased attention and the rush to embrace it resulting in the boom period. This third stage, euphoria, is especially pertinent given the research findings, as the boom phase results in not only a loss of caution but also individuals who are less likely to engage with risky markets following the herd without the benefit of expert knowledge.[67] This is reflective of a complaint made by 3.1% of survey respondents that there was a rush of investors buying into media hype and looking to "get rich quick". with their mistakes detrimental to the reputation of cryptocurrency. Next, a profit-making stage eventuates where those with more knowledge or investment acumen recognise the signs of a bubble and sell their holdings to those joining the rush into the market. Finally, the panic, driven by the recognition of an overvaluation and the market readjusting, results in a bust cycle (Minsky, 1986). As has been noted, the data collection methods of this research were not designed to address such actors and instead focus upon the users who consider themselves part of a community. Subsequently, Minsky (1986; 1992) offers a compelling argument that can be used to explain the manner in which the price of Bitcoin enters into a boom and bust cycle. This is the way the self-organised cryptocurrency community was ill-equipped to limit the transition from hedging to speculative and Ponzi financing. Nevertheless, such a theoretical approach represents a line of inquiry for future research, which will be addressed further in Section 8.3.

7.4. Summary

This thesis set out with the aim of addressing three distinct research questions which examine the extent and nature of the use of Bitcoin in hedging; the manner in which users perceive their own

[67] Although the majority of survey respondents are university-educated and professionally-employed, in this context it is worth noting that 12.1% are unemployed and 7.1% are employed in unskilled labour professions.

motivations, uses, and risks that drive their behaviour; and the nature of the relationship between cryptocurrency prices and indices of confidence. This research is set within the Bitcoin community who drove its existence from the start and understand its operation very well. The study explores these three issues over time as Bitcoin evolved, and interprets the data through the lens of the MMM framework. By employing various data sets, the utilisation of Bitcoin as an instrument of hedging was found to be but one facet of a larger Bitcoin marketplace, and, consequently, there is no statistically significant relationship between cryptocurrency prices and confidence. Instead, it is suggested that Bitcoin and its community have self-organised over time, with the emergence of social institutions and institutional entrepreneurship identifiable along a meso trajectory. This institutional and evolutionary analysis echoes the analysis of emerging institutional entrepreneurship of Teigland, et al. (2013), the three-phase evolutionary cycle identified by Tasca, et al. (2018), and the field of institutional cryptoeconomics (Berg, et al., 2018; Davidson, et al., 2018; Allen, et al., 2019; Gans and Catilini, 2019). Application of the MMM framework to this analysis is a contribution of this thesis. It adds Bitcoin specifically to the discussion from Berg, et al. (2018) on the blockchain decentralised ledgers and their institutional consequences. This thesis concludes with a final chapter offering a critical reflection on the research in its entirety. The final chapter also sets out strengths and weaknesses of the study design; the contribution of this thesis to the extant body of literature; and the implications of the findings as well as potential future lines of research to expand upon them.

8. Conclusion

The groundwork for this research was laid by an examination of the research landscape and the identification of gaps in the knowledge contained within the corpus of extant literature. These gaps were used to devise three research questions with the overarching consideration of understanding how Bitcoin is being used in a real-world context. In particular, the three formulated research questions sought to address the extent and nature of the use of Bitcoin in hedging; how individuals perceive their motivations, uses, and risks, and the manner in which it influences their behaviour; and the nature of the relationship between cryptocurrency prices and indices of consumer and investor confidence. As these questions are all interactively linked, the thesis focused on addressing the manner in which the composition and behaviours of the community of users influences the evolution of the Bitcoin market. Tied in to these questions were underpinning objectives including an emphasis on the Bitcoin community as opposed to the user base in its entirety. The thesis employed a multi-staged, mixed methods approach that combined semantic analysis, a user survey, and various econometric techniques, and the application of the micro-meso-macro (MMM) framework as an interpretative lens.

Chapter 4 presented the semantic analysis, which produced three key findings: firstly, that while internal risks generated more discussion than external risk, the former were regarded as problems to solve while the latter were perceived as hazards to be avoided; secondly, that the Bitcoin community was evolving over time to address internal hazards through means such as community watchdogs and ratings agencies; and thirdly, that there was a greater interest in long-term investments than in short-term profit-making. These findings were reinforced by the survey in Chapter 5, which added the following contributions: firstly, that the Bitcoin community can be broken down into five distinct clusters of users: catallactic, pure hedgers, casual, ideologically-

motivated, and profit-motivated. Each cluster is underpinned by different behaviours, motivations, and risk appreciation. Secondly, political ideology was the primary determining factor for cluster allocation. The empirical analysis in Chapter 6 showed that although there were some cointegrated relationships between the variables, there was no statistically significant relationship between Bitcoin prices and confidence. There were some Granger causal findings between Ethereum and business confidence at both the US and OECD levels, although these relationships were weak. These findings suggest that Bitcoin does not have a strong hedging function, serving as a medium of exchange without providing a store of value or method of deferred payment. As such, while Bitcoin possesses useful functions, especially in niche circumstances, it has yet to evolve into a true form of money that can compete with government-backed fiat currencies.

Upon completion of the empirical research, Chapter 7 tied the findings together in a discussion that addressed the research questions in terms of the MMM framework. It was determined that both the Bitcoin community and broader market are evolving along a meso trajectory into the adoption phase. At first, the community could best be understood as a market for preferences and a knowledge commons at the micro level, although over time it emerged as an innovations common, driving institutional entrepreneurship and the emergence of a catallaxy at the macro level. In terms of the research questions, it was determined that while the market for preferences provided a means of dealing with market uncertainty vis-à-vis the practice of hedging, such behaviour was limited to a subset of the community based on political preferences and similar factors. Likewise, while the motivations, uses, risk appreciation, and behaviours of individuals evolved alongside the community, there are five identifiable clusters of behaviour, with political ideology once again forming the most significant variable.

This chapter will conclude the thesis in a series of four sections. Section 8.1 will detail both the strengths and weaknesses of the study design. Section 8.2 will outline the contribution of the

research outcomes to the extant body of literature. Section 8.3 will discuss the implications of the thesis vis-à-vis future opportunities for research. Section 8.4 will offer concluding remarks.

8.1. Strengths and Limitations of the Research Design

Given that a core objective of this research has been to understand cryptocurrency not just in theoretical terms but from the point of view of its user base, the most significant limitation has been collecting data from a pseudonymous, decentralised, and globally-diffused body of individuals. This has produced a research environment in which data can only be solicited from a statistically significant number of users in places where people declare their use of Bitcoin, such as online community forums. Consequently, any data derived from these sources may not necessarily be reflective of the Bitcoin user base as a whole, but rather of those who engage with cryptocurrency in a social context, regarding themselves as part of a "community" that is representative of their values. The target demographic of this thesis has been this very "cryptocurrency community," as opposed to more disengaged users who only engage with Bitcoin to the extent that it is useful or profitable for them to do so. However, this does mean that any observations made about the Bitcoin community may not be reflective of the attitudes of the user base in its totality, limiting the extent to which the outcomes of this research can be applied. A further issue of this thesis was the innate flaws in user-derived data collection methods which could have biased or otherwise invalidated the research findings. However, this issue was addressed by the employment of a triangulation approach and a subsequent comparison of findings.

A further limitation of this thesis is the data employed to analyse Bitcoin in regard to its use in hedging and the inferences that can be derived from it. The emphasis on understanding how members of the Bitcoin community utilise cryptocurrency from their own perspective has lent itself to a focus on user-derived data, as typified by the semantic and survey analyses. While this has allowed the study to produce a number of findings that address the research questions, it has not

allowed the thesis to further refine the models of Bitcoin's role within a portfolio. As outlined in Section 2.3.3, the literature regarding this topic is contradictory due to a number of factors, including data limitations and uncertainty about the future of cryptocurrency. Section 2.3.5 outlines models underpinning this study's interpretation of hedging, but this was more to provide context to the discussion than a foundation that the data could build upon. As such, the findings of this thesis are limited to analysing hedging in the context of how members of the Bitcoin community perceive their own investment behaviours. However, it should be noted that this has allowed the thesis to avoid making underpinning assumptions that cannot be supported given the current state of the literature.

Another limitation of this research was the difficulty in identifying confidence variables suited to quantifying the possible relationship between Bitcoin prices and confidence identified in the literature. While the US and OECD data sets were employed because they serve as reliable indicators of trends on a global scale, they are also perhaps less prone to reflecting the impact of events which affect confidence on a localised or regionalised scale. As has been previously indicated, the lack of academic research into this topic means that the rejection at a global level of the notion that there is a significant relationship between cryptocurrency prices and economic confidence is a contribution in and of itself. This is significant in light of the extant literature that indicates such a relationship in localised and regionalised case studies.

8.2. Contribution of the Research

An important contribution of this research has been the application of the MMM framework and empirical analysis to the understanding of the Bitcoin community and market. In particular, the integration of both the empirical findings and relevant theories into the evolutionary framework provided by the meso trajectory has allowed this research to explore how the community has formed and changed over time, including why it exists and the functions that it provides. Berg, et al.

(2018) adopted the MMM framework as an interpretative lens in their research on the evolution of blockchain technology. This Bitcoin study takes the same interpretative lens and applies it to the evolution of cryptocurrency, and how this has been impacted by the behaviour of the user community. Indeed, much of the literature stemming from the field of institutional cryptoeconomics places emphasis on the blockchain, resulting in only extrapolations by this literature when it comes to applying insights to blockchain-based technologies such as cryptocurrency (MacDonald, et al., 2016; Davidson, et al., 2018; Allen, et al., 2019). As such, while grounded in other literature, the application of the MMM framework directly to cryptocurrencies without extrapolation represents an important contribution of this thesis, which can be readily applied to future research seeking to understand cryptocurrency within an evolutionary context.

Another aim of this research has been to emphasise the analysis of data derived from the user base to ground that perspective from the point of view of its users. As a consequence of seeking to understand cryptocurrency within a real-world context as opposed to employing existing theory to make inferences about user motivations and behaviour, this thesis has rejected some assumptions which are prevalent throughout the literature. The first of these is the notion that Bitcoin is an economic outgrowth of the libertarian political movement, as it represents a private alternative to the government and/or central bank monopoly over currency (De Filippi, 2014; Karlstrom, 2014). This study shows that while political identity does not necessarily appear to be a determinant of the decision to adopt Bitcoin, it does influence the manner in which cryptocurrency is utilised. Another common misconception addressed by this research is the notion that Bitcoin is a predominantly speculative investment, and that its user base is mostly concerned with short-term profit-making (Bouoiyour, et al., 2015; Cheah and Fry, 2015). As has been conceded throughout this analysis, users adhering to such a mentality are less likely to be captured by the data collection techniques employed in this research due to their limited engagement with the Bitcoin community. Nevertheless, while true in some circumstances, this argument tends to ignore the investment

preferences and behaviours of the user base commons community. In this context, the identification of the Bitcoin community as an innovation commons represents a significant finding of this research.

Finally, when identifying the contributions of this research to the extant literature, attention should be paid to the fact that this thesis applies both a conceptual framework for understanding Bitcoin and a sequential analytic methodological framework for analysing it within a social context. In attempting to devise a methodological approach capable of compensating for the difficulties of gathering data on the decentralised and pseudonymous Bitcoin user base, this thesis borrowed from the frameworks adopted by other researchers. In particular, the research looked at the semantic analysis approach utilised by Teigland, et al. (2013), the survey approach adopted by Smyth (2013; 2014), and the analysis of Google Trends data employed by Kristoufek (2013). Each of these methodological tools came with different strengths and limitations, all of which have been addressed throughout this thesis. The weaknesses inherent in employing only one of these approaches are identified by each author cited who adopted a single methodological tool in their research. Consequently, their research possessed no means of compensating for the inbuilt limitations in their methodology. This study ensured that by comparing findings produced via three different methods, understanding of the behaviour of cryptocurrency users is much deeper and more reliable, and its application helped compensate for the difficulties in user-derived data collection.

Although the potential for future work based upon the findings of this thesis will be addressed further in Section 8.3, the methodological approach devised for this research can be considered a general use format, capable of being reapplied to a wide range of topics unrelated to the lines of inquiry pursued within this work.

8.3. Future Opportunities for Research

With the contributions, strengths, and limitations of the thesis outlined, it is important to address the implications this body of work has in regard to future research in this field. Perhaps the most prominent of these is the need to continue refining the application of the MMM framework as a means of charting the evolution of the cryptocurrency community and market. As was noted when the MMM framework was proposed as an interpretative lens for data analysis, the limited timespan in which Bitcoin has existed limits the ability of the research to apply the full evolutionary analysis. After all, despite Bitcoin's rapid growth over the years, it has still yet to see widespread mainstream adoption, which makes the retention phase of the meso trajectory inapplicable to this analysis and even suggests that the adoption phase is far from completed. This, in turn, meant that the thesis was unable to offer any insights as to how maintenance occurs at the micro level and coordination emerges at the macro level. While it is possible to theorise based on extrapolation from the research findings, this was deemed outside the purview of this thesis, which is focused on Bitcoin within a contemporary context. As such, expanding on the foundation of this thesis, examining whether Bitcoin reaches this final stage of the meso trajectory is an opportunity for future research. This should begin immediately by a longitudinal study starting from this thesis' outcomes and continuing to map the evolution of Bitcoin and other altcoins over the following years as the evolution (or devolution) occurs.

Another major issue left unaddressed by this thesis is the determinants of Bitcoin's value and their impact on the boom-and-bust cycle, with confidence at the US and OECD levels having no statistically significant effects. While there are a number of theoretical and empirical approaches that can be employed to address this gap in the literature, the discussion chapter alluded to one worth addressing in the context of future opportunities for research. As noted in section 7.3 of the discussion chapter, Minsky (1992) offers insights into the manner in which hedge financing units can transition into speculative and then Ponzi financing units, resulting in a boom-and-bust cycle. Such a

process has implications for this research and future lines of inquiry based upon it for two reasons. Firstly, while the focus on the community rather than the broader user base meant that speculation featured less prominently in this analysis, such investment activity is prevalent in the Bitcoin market. Secondly, despite the collective self-organisation of informal groups including watchdog agencies to address such issues, such efforts are limited within the community and cannot reach all users (Mazzucato, 2018). Alternatively, legislative measures to reduce instability as argued by the Minsky hypothesis (most notably in the instance of "Know Your Customer" and "Anti-Money Laundering" laws, commonly referred to as KYC/AML) can be the starting point of an alternative to catallaxy. Subsequently, a deeper analysis of Minsky's theories and the manner in which they relate to the cryptocurrency market presents an opportunity for future research in the areas of interest extending from this thesis.

Additionally, this research presented a number of findings which constituted contributions to the literature but were not the primary focus of this thesis. These topics could benefit from more dedicated lines of inquiry seeking to address them further. A noteworthy example of this is the demographic composition of the Bitcoin community, particularly in regard to the clusters identified by this thesis. While there was sufficient data to identify political ideology as the key determinant of assignment to the catallactic users and pure hedger clusters, sample size limitations made it impossible to do the same with the other groups with any degree of accuracy. Another example is the disparity in representation between males and females in the Bitcoin community. The survey determined that only 5.25% of respondents were female, with the analysis of Smyth (2013), which derived a sample that was 4.8% female, suggesting that the male dominance of the community is not the product of a sampling error. To be sure, it is possible that the online communities targeted for data analysis possessed a pre-existing gender imbalance which was reflected in the demographics of the sample, but it seems unlikely that such a significant disparity can be attributed solely to such a phenomenon (Vasilescu, Capiluppi, and Serebrenik, 2014). The gender imbalance is

particularly noteworthy given the absence of any barriers to women accessing Bitcoin. It should be acknowledged that men are more likely to be disproportionately represented, albeit not to such extremes, in areas such as economics (Hopkins, 2004; Rask and Tiefenthaler, 2008), information-technology (Michie and Nelson, 2006; Wajcman, 2009), and financial risk-taking (Barber and Odean, 2001; Meier-Pesti and Penz, 2008; Olsen and Cox, 2010), all of which are areas that relate to cryptocurrency. Therefore, it is possible that the gender disparity in Bitcoin usage is the product of pre-existing gender imbalances in factors that increase the likelihood of individuals becoming interested in cryptocurrency. However, as noted by Murray and Powell (2011), even in societies where women possess the right to equal participation, structural inequalities continue to produce disparities regarding representation. This notion raises a number of prospects for future gender-based research, particularly in regard to the collective self-organisation of communities of cryptocurrency users.

Finally, attention should be given to the potential for replication studies of this thesis, as well as further research underpinned by data reflective of users in a real-world context. The methodological approach outlined in this thesis provides a blueprint for future research into Bitcoin which is unhindered by the limitations of a singular approach employed throughout much of the literature (Kristoufek, 2013; Smyth, 2013; 2014; Teigland, et al., 2013). Such an approach, whether combining semantic analysis with a survey or any other combination of methodological tools, will ensure more rigorous testing of findings within this field and ensure that theoretical assumptions are grounded in user-derived data. However, while the triangulation approach addresses many of the limitations regarding the collection of data on the Bitcoin user base and thus provides a greater degree of accuracy (at least relative to a singular methodological approach), it cannot compensate for all of them. In the context of this research, many of the findings derived through this methodological approach were consistent with the extant body of literature regarding cryptocurrency. For example, the notion that the cryptocurrency market is evolving over time and becoming more legitimate was

reflected by Tasca, et al. (2018); the determination that Bitcoin users are collectively self-organising to address problems is reminiscent of the research of Teigland, et al. (2013) into the emergence of institutional entrepreneurship; and the application of the MMM framework ties into the literature on institutional cryptoeconomics (MacDonald, et al., 2016; Davidson, et al., 2018; Allen, et al., 2019). However, given the methodological limitations surrounding research underpinned by analysing the Bitcoin user base itself, it must be emphasised that replication studies represent an important avenue for future research.

8.4. Concluding Remarks

The application of a multi-stage methodological approach and interpretation through a theoretical framework comprises a robust evaluation of the Bitcoin market and its users' characteristics. This thesis found that: (1) Bitcoin is a limited instrument of hedging which is influenced by institutional and political factors; (2) The Bitcoin community and marketplace seem to be growing more sophisticated as they evolve along a meso trajectory within the MMM framework, and its motivations, uses, and risks are reflective of its users' political ideology; and (3) there is no statistically significant relationship between cryptocurrency prices and indices of consumer and/or investor confidence. The emphasis on employing user-derived data to understand the motivations and behaviour of Bitcoin users served to additionally determine that: (4) The Bitcoin community has attitudinal differences to the appreciation of and response to internal and external risks, and how to achieve legitimacy in terms of both risks; (5) Bitcoin users are more concerned with longer-term investments than short-term profit-making via speculation and mining; (6) The cryptocurrency market has evolved over time, with a growing shift towards legitimate enterprises; and (7) Bitcoin users are collectively self-organising through various means to address problems via a market-based approach in the absence of any centralised authority.

Not only does this thesis offer a number of contributions to the literature, but it also provides a foundation upon which future research can be built across a wide array of topics. These include additional analysis using the MMM framework if or when Bitcoin reaches the retention stage of the meso trajectory, further refinement of the variables or theories to hone in on the predominant drivers of Bitcoin's price, and a methodological blueprint for collecting user-derived data without being subject to the limitations of a singular approach. Although there are indeed many more lines of inquiry to pursue when it comes to cryptocurrency, this thesis serves as both a contribution to the extant body of literature and a foundation for future research in this field.

The paucity of academic knowledge surrounding cryptocurrency is such that very few analyses have attempted to create an overarching conceptual framework for understanding Bitcoin, let alone employed a theoretical framework in this capacity. Nor are the predominant drivers of its value understood. Moreover, in the absence of a readily accessible source of user-derived data, the motivations and behaviour of Bitcoin users are often misunderstood and subject to generalisations which may not necessarily be accurate in light of the diverse array of preferences and behaviours identified by this research. The outcomes and findings of this thesis address all of these gaps, providing a significant and distinct contribution to the literature.

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Appendix A
Human Research Ethics Approval

Principal Researcher:	Dr Ernesto Valenzuela
Other/Student Researcher/s:	Corey Carter Associate Professor Jerry Courvisanos
School/Section:	**Federation Business School**
Project Number:	**B16-181**
Project Title:	**Hedging your bits: A critical examination of the relationship between cryptocurrency prices, economic confidence, and investment activity.**
For the period:	04/01/2017 **to** 31/03/2022

Quote the Project No: B16-181 in all correspondence regarding this application.

Please note: Ethics Approval is contingent upon the submission of Annual Progress reports and a Final report upon completion of the project. It is the responsibility of researchers to make a note of the following dates and submit these reports in a timely manner, as reminders may not be sent out. Failure to submit reports will result in your ethics approval lapsing

REPORTS TO HREC:

Annual reports for this project must be submitted to the Ethics Officer on:
4 January 2018
4 January 2019
4 January 2020
4 January 2021
4 January 2022

A Final report for this project must be submitted to the Ethics Officer on:
30 April 2022

These report forms can be found at:
http://federation.edu.au/research-and-innovation/research-support/ethics/human-ethics/human-ethics3

Fiona Koop
Ethics Officer
4 January 2017

Appendix B
Semantic Analysis Results

Table B.1: Frequency of mentions of "Scam." (Noun #75; 172,150 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	1	0	0	0	0	21	19	8	26	36	28
2011	21	94	50	62	209	448	519	530	422	413	346	257
2012	288	300	305	234	377	257	558	835	1,333	909	504	524
2013	852	760	1137	1864	2821	1891	1487	1924	2154	1414	2507	3340
2014	5314	5285	6735	5204	5167	6261	7198	6214	4865	4272	4149	4289
2015	4601	3626	4420	4317	3782	3970	3428	3383	4399	4000	3267	4088
2016	4813	3881	4168	4033	3901	4678	2355					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.2: Frequency of mentions of "Investment." (Noun #114; 124,506 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	5	1	1	0	0	25	38	17	47	47	53
2011	67	87	104	132	542	810	568	587	509	384	197	141
2012	248	195	303	354	519	560	535	981	1204	721	435	332
2013	435	487	1042	1647	1406	1815	1804	1833	1742	1136	2040	2364
2014	3015	3031	3780	3644	3201	3567	3738	3605	3242	2957	2233	2353
2015	2827	2321	2680	2580	2558	2572	2506	2360	2327	2505	2645	2460
2016	3405	3250	3631	3789	4746	5443	3030					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.3: Frequency of mentions of "Gold." (Noun #176; 86,461 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	23	15	2	2	18	201	241	51	101	176	254
2011	152	234	261	359	776	1590	1199	1112	911	688	414	371
2012	346	251	463	345	787	626	422	696	772	603	616	549
2013	641	902	1305	2287	1580	1299	1094	1026	765	1210	2359	2186
2014	2078	1818	2293	1692	1848	1775	1850	1684	1648	1708	1619	1484
2015	1308	1405	1629	1218	1275	1521	1982	1741	1333	1675	1595	1654
2016	2158	1954	1729	2172	2407	2575	1349					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.4: Frequency of mentions of "Security." (Noun #233; 64,253 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	2
2010	1	5	3	2	10	7	58	41	26	25	86	63
2011	80	103	125	172	360	1508	773	653	378	341	263	207
2012	273	275	396	254	429	416	468	569	810	989	366	480
2013	490	484	749	1177	1262	1117	1059	1151	1278	992	1281	1191
2014	1553	1537	2293	1670	1731	1823	1846	1451	1375	1303	1295	1147
2015	1359	1093	1457	1148	1063	1032	1021	1003	1242	1418	1187	1520
2016	1354	1110	1157	959	1122	1175	558					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.5: Frequency of mentions of "Altcoins." (Noun #327; 46,877 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	18	1	10	11	3
2012	23	12	12	7	4	13	24	7	25	23	20	14
2013	30	76	107	369	918	446	378	244	243	369	1011	1744
2014	2242	1706	2327	1613	1479	1456	1646	1739	1278	1253	1060	910
2015	943	988	1065	943	956	1109	982	826	937	1345	1323	1472
2016	1611	1181	1375	1277	1220	1639	809					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.6: Frequency of mentions of "Debt." (Noun #478; 31,840 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	0	0	0	0	0	48	45	9	7	32	55
2011	84	113	78	112	178	470	683	387	345	284	217	75
2012	175	147	306	259	225	224	231	636	741	414	378	350
2013	306	610	518	727	910	553	368	393	474	618	713	633
2014	712	605	836	706	883	784	726	1023	616	588	547	633
2015	561	643	651	578	475	626	737	467	434	500	462	474
2016	454	399	370	314	346	350	213					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.7: Frequency of mentions of "Inflation." (Noun #481; 31,715 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	1	17	19	0	0	5	110	124	29	53	34	70
2011	81	94	143	179	422	564	505	463	379	400	105	92
2012	104	55	142	162	170	131	88	209	316	152	147	288
2013	138	276	392	714	535	409	333	293	282	297	505	763
2014	956	777	1037	701	943	902	1202	988	945	573	741	631
2015	883	524	745	594	552	494	443	482	763	765	655	710
2016	612	369	423	385	375	425	330					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.8: Frequency of mentions of "Altcoin." (Noun #540; 27,684 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	12	3	10	7	4
2012	25	6	11	3	7	6	18	9	12	17	19	13
2013	16	35	60	183	534	228	162	121	113	143	462	797
2014	1059	942	941	797	741	797	908	981	721	672	618	631
2015	719	583	625	653	670	818	684	822	510	633	557	671
2016	873	815	968	1002	1101	1368	760					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.9: Frequency of mentions of "Speculation." (Noun #574; 25,949 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	2	0	1	0	1	8	9	2	9	111	12
2011	21	37	15	53	210	445	209	212	201	249	128	84
2012	197	105	112	76	117	125	182	219	171	211	114	109
2013	166	213	362	772	578	427	431	393	315	270	630	716
2014	720	842	965	725	588	620	635	642	618	556	463	418
2015	554	411	485	406	314	382	415	344	321	403	487	513
2016	491	455	615	587	722	854	361					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.10: Frequency of mentions of "Default." (Noun #578; 25,829 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	4
2010	1	3	1	3	7	5	29	48	21	32	32	36
2011	64	77	125	131	245	563	495	300	176	102	156	90
2012	196	212	198	201	297	226	361	611	462	250	250	224
2013	148	205	338	538	648	397	422	340	363	425	516	653
2014	770	760	644	644	653	600	654	677	490	503	439	449
2015	368	400	509	466	452	528	533	403	410	388	303	345
2016	415	352	361	351	364	248	113					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.11: Frequency of mentions of "Ponzi." (Noun #656; 21,819 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	4	6	7	10	24	15	36	31	18	2	5
2012	13	16	9	15	78	43	423	543	521	102	74	38
2013	36	44	74	98	56	47	64	110	102	55	106	63
2014	58	1177	963	459	348	361	328	324	311	391	490	767
2015	2130	1280	650	516	566	671	457	324	493	619	504	462
2016	707	542	871	631	530	678	330					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.12: Frequency of mentions of "Fraud." (Noun #695; 20,197 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	1	1	3	1	1	3	32	61	1	34	46	39
2011	41	53	53	70	126	242	302	204	175	89	116	92
2012	92	82	130	136	167	118	184	221	296	237	177	144
2013	238	141	177	380	338	268	209	403	289	227	355	424
2014	536	600	820	524	575	548	564	483	415	501	437	411
2015	480	391	516	634	368	291	281	333	367	297	262	327
2016	363	271	276	264	359	336	148					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.13: Frequency of mentions of "Volatility." (Noun #898; 14,843 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	2	0	0	0	1	0	0	0	10	6	4
2011	1	9	17	22	52	214	135	153	109	162	120	76
2012	170	52	65	30	108	79	113	160	71	41	51	29
2013	53	99	189	727	350	150	265	115	170	156	406	582
2014	404	469	457	408	353	293	311	379	398	363	302	306
2015	460	277	287	241	229	258	323	236	157	238	364	267
2016	266	218	243	260	213	416	223					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.14: Frequency of mentions of "Litecoin." (Proper Noun #34; 29,863 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	0	0	0	0	0	0	0	0	1	0	0
2011	0	0	0	0	0	0	0	0	3	187	132	98
2012	69	178	105	41	64	92	331	134	114	207	102	146
2013	103	206	721	1367	1196	801	562	374	294	437	939	1165
2014	1405	1101	1523	982	936	1387	1026	978	638	594	331	334
2015	505	377	363	308	318	498	693	439	295	268	446	282
2016	350	275	336	377	306	342	174					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.15: Frequency of mentions of "Dogecoin." (Proper Noun #109; 14,095 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											O	0
2010	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	1	0
2012	0	0	0	0	0	0	0	0	0	0	0	1
2013	0	0	1	0	1	2	0	0	0	0	4	1310
2014	1343	1242	991	705	688	442	477	497	488	371	279	308
2015	322	246	236	204	199	151	162	159	144	138	355	165
2016	190	120	128	125	139	114	77					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.16: Frequency of mentions of "Ponzi." (Proper Noun #128; 12,444 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	0	1	0	0	0	6	13	1	0	2	3
2011	7	18	20	10	62	83	98	32	27	53	11	17
2012	15	9	16	28	94	31	306	403	289	40	74	14
2013	34	33	123	148	80	50	100	133	69	44	149	130
2014	109	633	640	365	228	245	276	217	190	178	234	254
2015	853	434	201	275	231	246	182	172	172	220	240	181
2016	262	266	555	274	384	354	166					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.17: Frequency of mentions of "Ethereum." (Proper Noun #199; 8,375 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	2
2014	239	161	107	109	68	75	213	276	102	77	109	77
2015	105	66	112	54	52	42	88	351	245	196	159	150
2016	327	657	960	709	835	1149	384					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.18: Frequency of mentions of "Altcoin." (Proper Noun #383; 4,370 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	36	0	0	9	0
2012	3	1	3	2	1	0	0	0	0	1	1	0
2013	0	2	3	9	65	22	20	10	6	23	34	73
2014	128	204	163	106	77	182	197	158	195	123	159	91
2015	155	68	82	77	83	75	70	77	65	95	119	99
2016	125	74	120	95	74	133	58					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.19: Frequency of mentions of "Peercoin." (Proper Noun #391; 4,324 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	1	0
2013	0	0	0	3	8	4	4	2	6	37	248	223
2014	255	151	167	228	174	211	208	73	264	79	117	88
2015	82	71	107	121	71	92	82	78	52	68	68	65
2016	54	54	65	66	71	70	47					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.20: Frequency of mentions of "Steal." (Verb #163; 68,866 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	3	3	0	5	5	44	89	16	69	43	73
2011	73	166	158	185	329	1410	693	628	384	349	284	209
2012	330	275	663	246	500	377	539	479	651	474	410	401
2013	331	345	617	1130	1406	938	954	879	803	678	1239	1384
2014	2150	2645	3129	2023	1850	2022	2243	1942	1651	1710	1180	1315
2015	1667	1515	1720	1392	1297	1119	1135	1063	1021	970	908	1112
2016	1617	1216	1415	1206	1311	1337	715					

Source: Author's data derived from webscraping of Bitcointalk.org.

Table B.21: Frequency of mentions of "Hack." (Verb #496; 17,528 mentions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009											0	0
2010	0	1	0	2	1	1	15	16	5	5	6	23
2011	7	19	35	34	68	400	131	131	105	97	43	47
2012	58	66	83	58	98	77	129	75	116	74	52	71
2013	87	69	105	329	286	191	208	123	160	147	273	371
2014	482	463	589	347	296	373	385	484	428	321	252	300
2015	524	498	504	423	501	531	418	373	304	315	311	377
2016	608	475	392	454	508	536	258					

Source: Author's data derived from webscraping of Bitcointalk.org.

Appendix C
Survey Questions and Results

Section A: Respondent Demographics

What is your gender?

Answer	Number of Respondents	Percentage
Male	361	94.75%
Female	20	5.25%

Source: Author's data derived from survey responses.

How old are you?

Answer	Number of Respondents	Percentage
18 to 29 years old	156	40.94%
30 to 39 years old	147	38.58%
40 to 49 years old	52	13.65%
50 to 59 years old	17	4.46%
60 to 60 years old	7	1.84%
70 or over	2	0.52%

Source: Author's data derived from survey responses.

What is your main country of residence?

Answer	Number of Respondents	Percentage
American Samoa	1	0.26%
Argentina	1	0.26%
Australia	39	10.24%
Austria	5	1.31%
Bangladesh	1	0.26%
Barbados	1	0.26%
Belgium	1	0.26%
Bermuda	1	0.26%
Bosnia and Herzegovina	1	0.26%
Brazil	7	1.84%
Bulgaria	2	0.52%
Canada	22	5.77%
Croatia	2	0.52%
Cyprus	1	0.26%

Czech Republic	7	1.84%
Denmark	2	0.52%
Finland	2	0.52%
France	5	1.31%
Germany	20	5.25%
Ghana	1	0.26%
Greece	2	0.52%
Hong Kong	1	0.26%
Hungary	4	1.05%
Iceland	1	0.26%
India	4	1.05%
Indonesia	1	0.26%
Ireland	5	1.31%
Israel	2	0.52%
Italy	3	0.79%
Japan	1	0.26%
Kosovo	1	0.26%
Lebanon	1	0.26%
Lithuania	2	0.52%
Malta	1	0.26%
Netherlands	13	3.41%
New Zealand	5	1.31%
Nicaragua	1	0.26%
Norway	4	1.05%
Philippines	2	0.52%
Poland	4	1.05%
Portugal	2	0.52%
Russia	4	1.05%
Singapore	1	0.26%
Slovakia	1	0.26%
South Africa	5	1.31%
South Korea	1	0.26%
Spain	6	1.57%
Sweden	2	0.52%
Switzerland	6	1.57%
Taiwan	2	0.52%
Thailand	1	0.26%
Trinidad and Tobago	1	0.26%
Turkey	1	0.26%
United Arab Emirates	1	0.26%
United Kingdom	30	7.87%
United States	135	35.46%
Uruguay	1	0.26%
Vatican City	1	0.26%

Source: Author's data derived from survey responses.

What is the highest level of education you have attained?

Answer	Number of Respondents	Percentage
High School Graduate or Lower	56	14.7%
Trade/Technical/Vocation Training	30	7.87%
Associate Degree	26	6.82%
Bachelor's Degree	159	41.73%
Master's Degree	83	21.78%
Doctorate	27	7.09%

Source: Author's data derived from survey responses.

What is your occupation?

Answer	Number of Respondents	Percentage
Unemployed	46	12.07%
Unskilled Employee	27	7.09%
Skilled Certificate Employee	42	11.02%
Professional Degree-Based Employee	164	43.04%
Self-Employed	83	21.76%
Executive Partner or Board Member	8	2.1%
Retired	11	2.89%

Source: Author's data derived from survey responses.

Which of the following best describes your political views?

Answer	Number of Respondents	Percentage
Centre-left/Liberal	82	21.52%
Centre-right/Conservative	33	8.66%
Centrist/Moderate	47	12.34%
Progressive	40	10.5%
Socialist	22	5.77%
Communist	6	1.57%
Libertarian	83	21.78%
Anarchocapitalist	30	7.87%
Anarchocommunist/Anarchosyndicalist	11	2.89%
Alt-Right	1	0.26%
Other	26	6.82%

Source: Author's data derived from survey responses.

In what year did you first start using Bitcoin?

Answer	Number of Respondents	Percentage
2017	58	15.22%
2016	42	11.02%
2015	32	8.4%
2014	55	14.44%
2013	90	23.62%
2012	44	11.55%
2011	41	10.76%
2010	12	3.15%
2009	7	1.84%

Source: Author's data derived from survey responses.

Which of the following best describes the way you use Bitcoin?

Answer	Number of Respondents	Percentage
Commercial	10	2.62%
Speculative	21	5.51%
Investment	101	26.51%
Hedging	12	3.15%
Commercial and speculative	17	4.46%
Commercial and investment	52	13.65%
Commercial and hedging	3	0.79%
Speculative and investment	37	9.71%
Speculative and hedging	4	1.05%
Investment and hedging	28	7.35%
Commercial, speculative, and investment	18	4.72%
Commercial, speculative, and hedging	3	0.79%
Commercial, investment, and hedging	17	4.46%
Speculative, investment, and hedging	13	3.41%
All of the above	45	11.81%

Source: Author's data derived from survey responses.

Section B: Confidence Ratings

On a scale of 1 to 5, with 1 being 'not at all important' and 5 being 'extremely important,' rate how influential the following factors are in your use of Bitcoin.

Question	1	2	3	4	5
Deriving a profit from mining bitcoins.	281 (73.75%)	38 (9.97%)	25 (6.56%)	10 (2.62%)	27 (7.09%)
Deriving a profit from speculating on changes in bitcoin prices.	114 (29.92%)	77 (20.21%)	89 (23.36%)	55 (14.44%)	46 (12.07%)
Deriving a profit from long-term investments.	16 (4.2%)	9 (2.36%)	34 (8.92%)	93 (24.41%)	229 (60.1%)
Protecting yourself from the impact of inflation.	33 (8.66%)	38 (9.97%)	68 (17.85%)	84 (22.05%)	158 (41.47%)
Protecting yourself from government activities (e.g. seizure of assets).	46 (12.07%)	52 (13.65%)	60 (15.75%)	76 (19.95%)	147 (38.58%)
Protecting yourself from risks in the mainstream (non-Bitcoin) economy.	44 (11.55%)	29 (7.61%)	84 (22.05%)	101 (26.51%)	123 (32.28%)
Providing additional economic security.	25 (6.56%)	24 (6.3%)	62 (16.27%)	135 (35.43%)	135 (35.43%)
Lack of confidence in the local economy.	75 (19.69%)	82 (21.52%)	88 (23.1%)	65 (17.06%)	71 (18.64%)
Lack of confidence in the global economy.	49 (12.86%)	58 (15.22%)	89 (23.36%)	89 (23.36%)	96 (25.2%)
Diversifying your assets in an investment portfolio.	54 (14.17%)	49 (12.86%)	79 (20.73%)	104 (27.3%)	95 (24.93%)
Lowering the cost of online transactions (Money transfers, online purchases, etc.).	72 (18.9%)	69 (18.11%)	102 (26.77%)	70 (18.37%)	68 (17.85%)
Ideological reasons (e.g. opposition to government/central bank control).	34 (8.92%)	41 (10.76%)	59 (15.49%)	77 (20.21%)	170 (44.62%)
Curiosity.	29 (7.61%)	38 (9.97%)	88 (23.1%)	108 (28.35%)	118 (30.97%)
Seeking an intellectual challenge.	48 (12.6%)	41 (10.76%)	88 (23.1%)	113 (29.66%)	91 (23.88%)
Becoming part of a broader "Bitcoin community."	81 (21.26%)	78 (20.47%)	85 (22.31%)	85 (22.31%)	52 (13.65%)

Source: Author's data derived from survey responses.

On a scale of 1 to 5, with 1 being 'not at all concerned' and 5 being 'extremely concerned,' rate how concerned you are about the following mainstream and Bitcoin-related economic risks.

Question	1	2	3	4	5
Inflation.	41 (10.76%)	50 (13.12%)	73 (19.16%)	103 (27.03%)	114 (29.92%)
Deflation.	127 (33.33%)	109 (28.61%)	71 (18.64%)	43 (11.29%)	31 (8.14%)
Taxation.	48 (12.6%)	52 (13.65%)	90 (23.62%)	93 (24.41%)	98 (25.72%)
Government debt.	45 (11.81%)	53 (13.91%)	64 (16.8%)	100 (26.25%)	119 (31.23%)
Recession/Depression.	31 (8.14%)	59 (15.49%)	73 (19.16%)	108 (28.35%)	110 (28.87%)
Hacking and theft of your bitcoins.	52 (13.65%)	87 (22.83%)	74 (19.42%)	82 (21.52%)	86 (22.57%)
Becoming the victim of a bitcoin scam.	142 (37.27%)	114 (29.92%)	52 (13.65%)	36 (9.45%)	37 (9.71%)
Bitcoin price fluctuations.	93 (24.41%)	109 (28.61%)	96 (25.2%)	62 (16.27%)	21 (5.51%)
Bitcoin Ponzi schemes.	190 (49.87%)	97 (25.46%)	43 (11.29%)	28 (7.35%)	23 (6.04%)
Increasing government intervention/regulation of Bitcoin.	36 (9.45%)	53 (13.91%)	77 (20.21%)	96 (25.2%)	119 (31.23%)
The use of Bitcoin in illegal activities.	203 (53.28%)	84 (22.05%)	49 (12.86%)	28 (7.35%)	17 (4.46%)

Source: Author's data derived from survey responses.

On a scale of 1 to 5, with 1 being 'no trust at all' and 5 being 'extremely trusted,' rate how much you trust the following mainstream and Bitcoin-related institutions.

Question	1	2	3	4	5
The federal/central government of your country of residence.	113 (29.66%)	109 (28.61%)	98 (25.72%)	47 (12.34%)	14 (3.67%)
The central bank of your country of residence.	125 (32.81%)	108 (28.35%)	96 (25.2%)	35 (9.19%)	17 (4.46%)
Mainstream financial institutions (e.g. banks).	116 (30.45%)	140 (36.75%)	87 (22.83%)	33 (8.66%)	5 (1.31%)
Third party payment systems (e.g. PayPal).	84 (22.05%)	114 (29.92%)	129 (33.86%)	44 (11.55%)	10 (2.62%)
International financial institutions (e.g. International Monetary Fund, World Bank).	142 (37.27%)	112 (29.4%)	93 (24.41%)	28 (7.35%)	6 (1.57%)
The Bitcoin Foundation.	74 (19.42%)	80 (21%)	150 (39.37%)	60 (15.75%)	17 (4.46%)
Bitcoin core developers.	60 (15.75%)	43 (11.29%)	100 (26.25%)	94 (24.67%)	84 (22.05%)
Bitcoin exchanges.	33 (8.66%)	121 (31.76%)	159 (41.73%)	56 (14.7%)	12 (3.15%)
Bitcoin wallet providers.	20 (5.25%)	63 (16.54%)	143 (37.53%)	123 (32.28%)	32 (8.4%)
Bitcoin mining pools.	61 (16.01%)	105 (27.56%)	145 (38.06%)	53 (13.91%)	17 (4.46%)
Altcoin developers.	72 (18.9%)	124 (32.55%)	129 (33.86%)	44 (11.55%)	12 (3.15%)

Source: Author's data derived from survey responses.

Section C: Short Answer Questions

Were there other influential motivators behind your decision to use Bitcoin not mentioned in the previous section? If so, what were they?

Answer	Number of Respondents	Percentage
No	126	42.86%
Yes, but already covered.	41	13.95%
Revolutionary potential.	42	14.29%
Economic sovereignty/freedom.	16	5.4%
Transparency/Decentralisation.	14	4.8%
Making illicit purchases.	11	3.7%
Friend recommendation.	10	3.4%
Economic opportunity.	6	2%
Easier international transfers.	5	1.7%
Fun.	4	1.4%
Pseudo-anonymity.	1	1%
Other.	16	5.4%

Source: Author's data derived from survey responses.

What are your main concerns about the state of the mainstream economy today, both locally and globally? Why do these issues concern you?

Answer	Number of Respondents	Percentage
No concerns.	42	14.3%
Government debt.	48	16.3%
Inflation.	45	15.3%
Corruption of institutions.	40	13.6%
Distrust of central banks and fiat currencies.	35	11.9%
Coming economic collapse.	21	7.1%
Income inequality.	12	4.1%
Big government.	9	3.1%
Rise of far-left/far-right.	5	1.7%
Automation.	5	1.7%
Capitalism.	5	1.7%
Taxation.	3	1%
Cashless economy.	3	1%
Other.	21	7.1%

Source: Author's data derived from survey responses.

What are your main concerns about the state of the cryptocurrency market today? Why do these issues concern you?

Answer	Number of Respondents	Percentage
Government intervention.	56	19%
Scaling debate and infighting.	54	18.4%
Mining centralisation.	50	17%
Altcoin scams.	28	9.5%
Lack of mainstream adoption.	27	9.2%
Inexperienced newcomers looking to get rich quick.	9	3.1%
Volatility.	9	3.1%
The Bitcoin core developers.	8	2.7%
Future Bitcoin market crash.	8	2.7%
Security concerns.	7	2.4%
Lack of regulatory clarity.	3	1%
Speculation.	3	1%
Blockchain hard fork.	3	1%
No concerns.	20	6.8%
Other.	9	3.1%

Source: Author's data derived from survey responses.

Did any specific economic event lead to your decision to start using Bitcoin? This can include localised conditions within your region or broader global concerns. If so, please specify.

Answer	Number of Respondents	Percentage
No.	179	60.9%
Yes, 2008 financial crisis.	39	13.27%
Yes, local government issue.	21	7.14%
Yes, local issue with banks.	15	5.1%
Yes, inflation.	6	2%
Yes, national debt concerns.	4	1.4%
Yes, Greek debt crisis.	4	1.4%
Yes, Cypriot financial crisis.	3	1%
Yes, Brexit.	3	1%
Yes, positive news about Bitcoin.	14	4.76%
Yes, unspecified.	6	2%

Source: Author's data derived from survey responses.

Have you ever used Bitcoin to protect the long-term value of your wealth from some perceived threat? If so, what and why?

Answer	Number of Respondents	Percentage
No.	155	52.8%
Yes, inflation.	61	20.7%
Yes, from government.	12	4.1%
Yes, from taxation.	8	2.7%
Yes, from future collapse.	9	3.1%
Yes, from dollar collapse.	6	2%
Yes, from banks.	6	2%
Yes, from local economic issues.	7	2.4%
Yes, unspecified.	30	10.2%

Source: Author's data derived from survey responses.

Do you use Bitcoin as part of an investment portfolio? If so, what role would you describe Bitcoin as playing in your investment activities?

Answer	Number of Respondents	Percentage
No.	68	23.1%
Yes, unspecified.	17	5.8%
Yes, only investment.	31	10.5%
Yes, major investment.	60	20.4%
Yes, minor investment.	36	12.2%
Yes, as a long-term holding.	26	8.8%
Yes, as a hedge.	25	7.5%
Yes, as high-risk, high-reward portion.	21	7.1%
Yes, for speculation.	10	3.4%

Source: Author's data derived from survey responses.

To what extent do you believe that the public perception of Bitcoin as being volatile, prone to cybercrime, and used in illegal activities, is accurate? 294

Answer	Number of Respondents	Percentage
Not at all accurate.	123	41.8%
Mostly inaccurate.	28	9.5%
Somewhat accurate, largely exaggerated.	58	19.7%
About 50/50.	6	2%
Accurate but irrelevant.	38	12.9%
Mostly accurate.	5	1.7%
Completely accurate.	26	8.8%
Uncertain.	10	3.4%

Source: Author's data derived from survey responses.

Do you believe that the Bitcoin market has changed over time to better combat the dangers specified in the question above? Please provide examples to explain your reasoning.

Answer	Number of Respondents	Percentage
No.	81	27.6%
Uncertain.	42	14.3%
Yes, unspecified.	24	8.2%
Yes, security software improved.	58	19.7%
Yes, transition from illicit to legal use.	43	14.6%
Yes, introduction of KYC/AML laws.	21	7.1%
Yes, less volatility.	12	4.1%
Yes, changing public perceptions.	10	3.4%
Yes, other.	3	1%

Source: Author's data derived from survey responses.

Do you, or have you in the past, used any cryptocurrencies other than Bitcoin? If not, why not? If so, which cryptocurrencies did you use and why?

Answer	Number of Respondents	Percentage
Yes, unspecified.	89	30.3%
Yes, for privacy.	29	9.9%
Yes, for speculation.	28	9.5%
Yes, for diversification.	18	6.1%
Yes, for investment.	16	5.4%
Yes, as a hedge.	9	3%
Yes, for commercial use.	6	2%
Yes, out of curiosity.	5	1.7%
Yes, prefers altcoins.	3	1%
Previously dabbled but preferred Bitcoin.	24	8.2%
No, unspecified.	48	16.3%
No, distrust altcoins.	16	5.4%
No, but plan to eventually.	3	1%

Source: Author's data derived from survey responses.

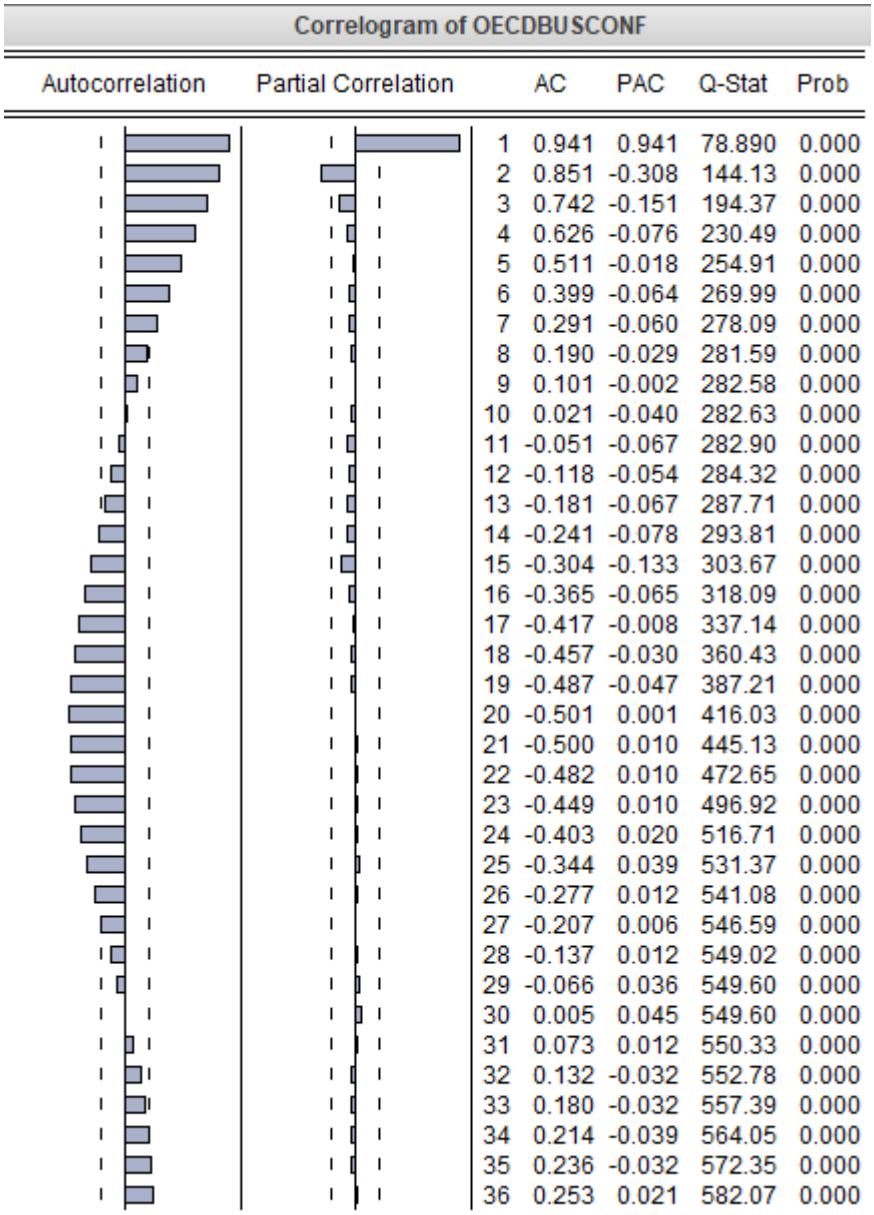
Do you believe that over the long term, Bitcoin will come to face stronger competition from other cryptocurrencies or even be replaced by a more successful alternative? Why or why not?

Answer	Number of Respondents	Percentage
Yes, unspecified.	13	4.4%
Yes, due to technological advancement.	81	27.6%
Yes, due to niche specialisation.	15	5.1%
Yes, due to distrust of Bitcoin core developers.	6	2%
Yes, due to lack of scalability.	5	1.7%
No, unspecified.	14	4.8%
No, due to network size and first mover advantage.	101	34.4%
No, due to improvements being assimilated.	4	1.4%
No, due to distrust of altcoins.	4	1.4%
Uncertain.	51	17.3%

Source: Author's data derived from survey responses.

Appendix D
Correlogram Results

Figure D.1: Correlogram of OECD Business Confidence Index

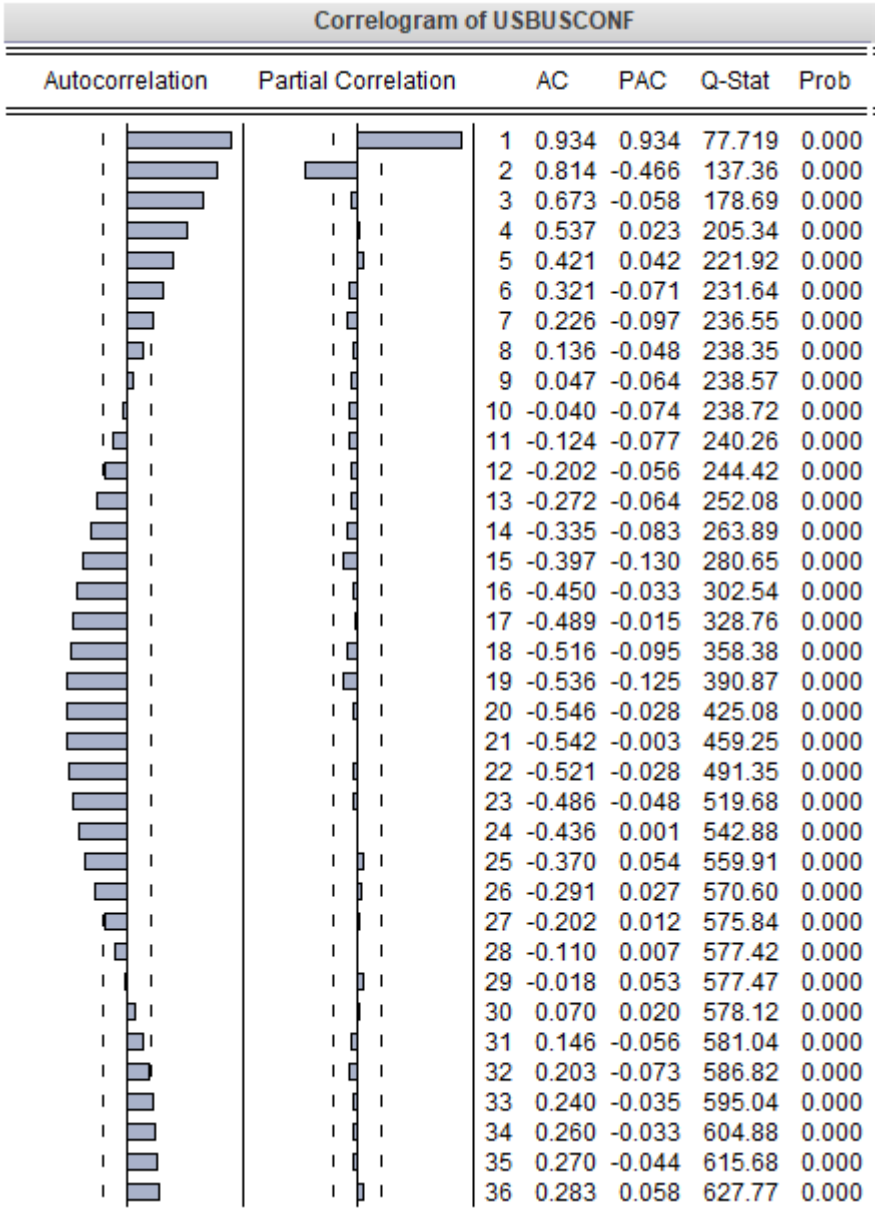


Correlogram of OECDBUSCONF

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.941	0.941	78.890	0.000
		2	0.851	-0.308	144.13	0.000
		3	0.742	-0.151	194.37	0.000
		4	0.626	-0.076	230.49	0.000
		5	0.511	-0.018	254.91	0.000
		6	0.399	-0.064	269.99	0.000
		7	0.291	-0.060	278.09	0.000
		8	0.190	-0.029	281.59	0.000
		9	0.101	-0.002	282.58	0.000
		10	0.021	-0.040	282.63	0.000
		11	-0.051	-0.067	282.90	0.000
		12	-0.118	-0.054	284.32	0.000
		13	-0.181	-0.067	287.71	0.000
		14	-0.241	-0.078	293.81	0.000
		15	-0.304	-0.133	303.67	0.000
		16	-0.365	-0.065	318.09	0.000
		17	-0.417	-0.008	337.14	0.000
		18	-0.457	-0.030	360.43	0.000
		19	-0.487	-0.047	387.21	0.000
		20	-0.501	0.001	416.03	0.000
		21	-0.500	0.010	445.13	0.000
		22	-0.482	0.010	472.65	0.000
		23	-0.449	0.010	496.92	0.000
		24	-0.403	0.020	516.71	0.000
		25	-0.344	0.039	531.37	0.000
		26	-0.277	0.012	541.08	0.000
		27	-0.207	0.006	546.59	0.000
		28	-0.137	0.012	549.02	0.000
		29	-0.066	0.036	549.60	0.000
		30	0.005	0.045	549.60	0.000
		31	0.073	0.012	550.33	0.000
		32	0.132	-0.032	552.78	0.000
		33	0.180	-0.032	557.39	0.000
		34	0.214	-0.039	564.05	0.000
		35	0.236	-0.032	572.35	0.000
		36	0.253	0.021	582.07	0.000

Source: Author's data derived from correlogram of OECD (2017a).

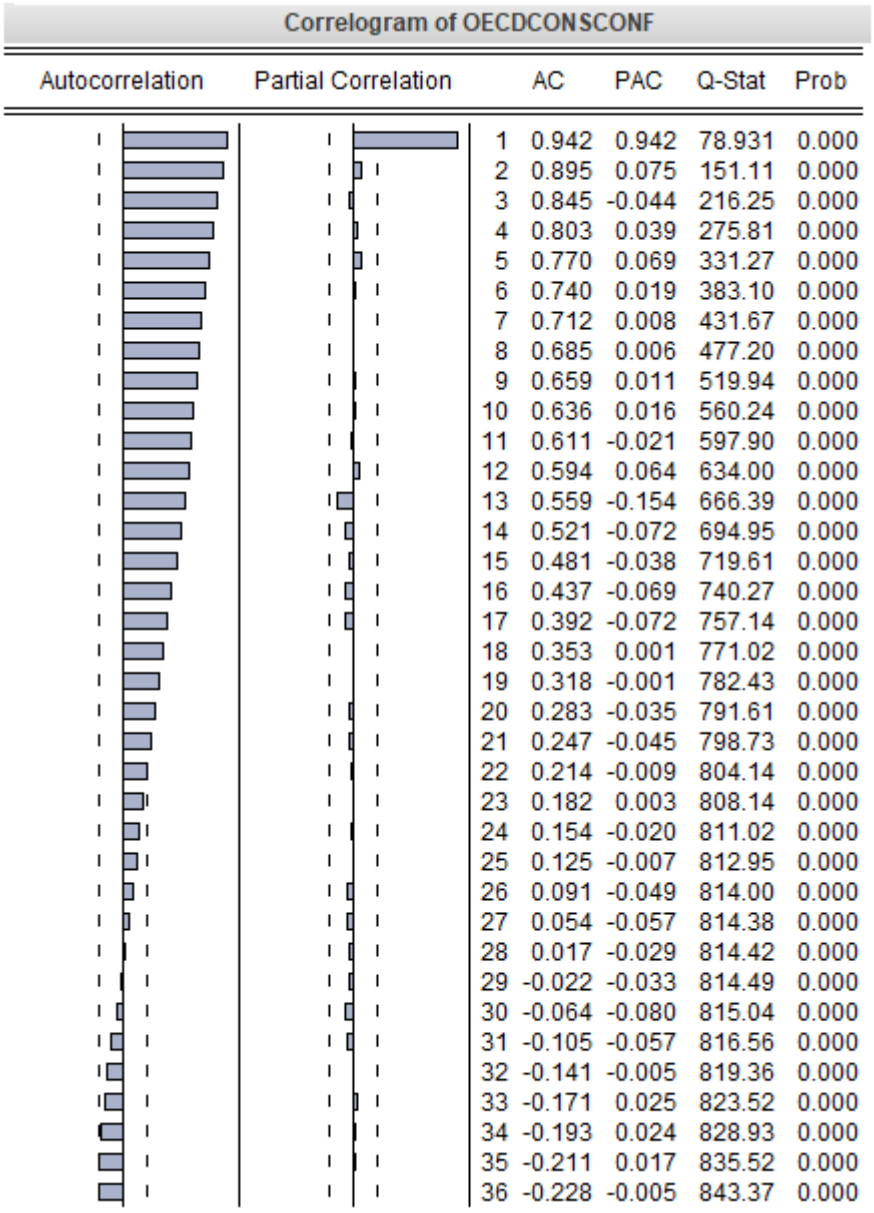
Figure D.2: Correlogram of US Business Confidence Index



	AC	PAC	Q-Stat	Prob
1	0.934	0.934	77.719	0.000
2	0.814	-0.466	137.36	0.000
3	0.673	-0.058	178.69	0.000
4	0.537	0.023	205.34	0.000
5	0.421	0.042	221.92	0.000
6	0.321	-0.071	231.64	0.000
7	0.226	-0.097	236.55	0.000
8	0.136	-0.048	238.35	0.000
9	0.047	-0.064	238.57	0.000
10	-0.040	-0.074	238.72	0.000
11	-0.124	-0.077	240.26	0.000
12	-0.202	-0.056	244.42	0.000
13	-0.272	-0.064	252.08	0.000
14	-0.335	-0.083	263.89	0.000
15	-0.397	-0.130	280.65	0.000
16	-0.450	-0.033	302.54	0.000
17	-0.489	-0.015	328.76	0.000
18	-0.516	-0.095	358.38	0.000
19	-0.536	-0.125	390.87	0.000
20	-0.546	-0.028	425.08	0.000
21	-0.542	-0.003	459.25	0.000
22	-0.521	-0.028	491.35	0.000
23	-0.486	-0.048	519.68	0.000
24	-0.436	0.001	542.88	0.000
25	-0.370	0.054	559.91	0.000
26	-0.291	0.027	570.60	0.000
27	-0.202	0.012	575.84	0.000
28	-0.110	0.007	577.42	0.000
29	-0.018	0.053	577.47	0.000
30	0.070	0.020	578.12	0.000
31	0.146	-0.056	581.04	0.000
32	0.203	-0.073	586.82	0.000
33	0.240	-0.035	595.04	0.000
34	0.260	-0.033	604.88	0.000
35	0.270	-0.044	615.68	0.000
36	0.283	0.058	627.77	0.000

Source: Author's data derived from correlogram of OECD (2017a).

Figure D.3: Correlogram of OECD Consumer Confidence Index

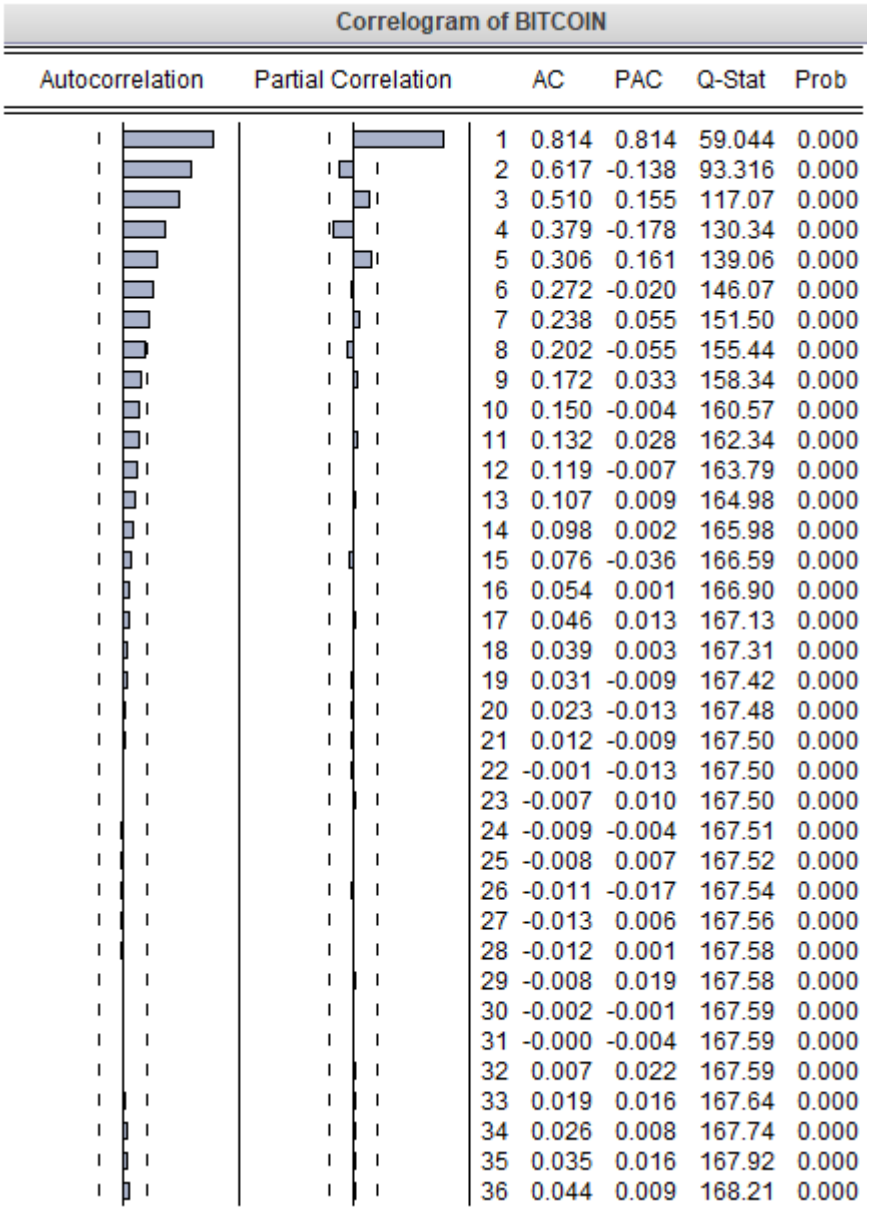


Correlogram of OECDCONSCONF

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.942	0.942	78.931	0.000
		2	0.895	0.075	151.11	0.000
		3	0.845	-0.044	216.25	0.000
		4	0.803	0.039	275.81	0.000
		5	0.770	0.069	331.27	0.000
		6	0.740	0.019	383.10	0.000
		7	0.712	0.008	431.67	0.000
		8	0.685	0.006	477.20	0.000
		9	0.659	0.011	519.94	0.000
		10	0.636	0.016	560.24	0.000
		11	0.611	-0.021	597.90	0.000
		12	0.594	0.064	634.00	0.000
		13	0.559	-0.154	666.39	0.000
		14	0.521	-0.072	694.95	0.000
		15	0.481	-0.038	719.61	0.000
		16	0.437	-0.069	740.27	0.000
		17	0.392	-0.072	757.14	0.000
		18	0.353	0.001	771.02	0.000
		19	0.318	-0.001	782.43	0.000
		20	0.283	-0.035	791.61	0.000
		21	0.247	-0.045	798.73	0.000
		22	0.214	-0.009	804.14	0.000
		23	0.182	0.003	808.14	0.000
		24	0.154	-0.020	811.02	0.000
		25	0.125	-0.007	812.95	0.000
		26	0.091	-0.049	814.00	0.000
		27	0.054	-0.057	814.38	0.000
		28	0.017	-0.029	814.42	0.000
		29	-0.022	-0.033	814.49	0.000
		30	-0.064	-0.080	815.04	0.000
		31	-0.105	-0.057	816.56	0.000
		32	-0.141	-0.005	819.36	0.000
		33	-0.171	0.025	823.52	0.000
		34	-0.193	0.024	828.93	0.000
		35	-0.211	0.017	835.52	0.000
		36	-0.228	-0.005	843.37	0.000

Source: Author's data derived from correlogram of OECD (2017b).

Figure D.4: Correlogram of Bitcoin Price Index

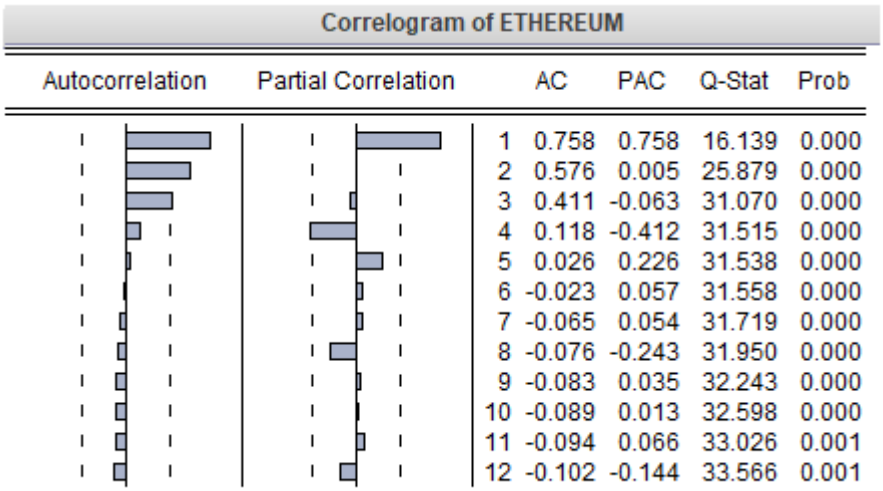


Correlogram of BITCOIN

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.814	0.814	59.044	0.000
		2	0.617	-0.138	93.316	0.000
		3	0.510	0.155	117.07	0.000
		4	0.379	-0.178	130.34	0.000
		5	0.306	0.161	139.06	0.000
		6	0.272	-0.020	146.07	0.000
		7	0.238	0.055	151.50	0.000
		8	0.202	-0.055	155.44	0.000
		9	0.172	0.033	158.34	0.000
		10	0.150	-0.004	160.57	0.000
		11	0.132	0.028	162.34	0.000
		12	0.119	-0.007	163.79	0.000
		13	0.107	0.009	164.98	0.000
		14	0.098	0.002	165.98	0.000
		15	0.076	-0.036	166.59	0.000
		16	0.054	0.001	166.90	0.000
		17	0.046	0.013	167.13	0.000
		18	0.039	0.003	167.31	0.000
		19	0.031	-0.009	167.42	0.000
		20	0.023	-0.013	167.48	0.000
		21	0.012	-0.009	167.50	0.000
		22	-0.001	-0.013	167.50	0.000
		23	-0.007	0.010	167.50	0.000
		24	-0.009	-0.004	167.51	0.000
		25	-0.008	0.007	167.52	0.000
		26	-0.011	-0.017	167.54	0.000
		27	-0.013	0.006	167.56	0.000
		28	-0.012	0.001	167.58	0.000
		29	-0.008	0.019	167.58	0.000
		30	-0.002	-0.001	167.59	0.000
		31	-0.000	-0.004	167.59	0.000
		32	0.007	0.022	167.59	0.000
		33	0.019	0.016	167.64	0.000
		34	0.026	0.008	167.74	0.000
		35	0.035	0.016	167.92	0.000
		36	0.044	0.009	168.21	0.000

Source: Author's data derived from correlogram of CoinDesk (2017a).

Figure D.5: Correlogram of Ethereum Price Index



	AC	PAC	Q-Stat	Prob
1	0.758	0.758	16.139	0.000
2	0.576	0.005	25.879	0.000
3	0.411	-0.063	31.070	0.000
4	0.118	-0.412	31.515	0.000
5	0.026	0.226	31.538	0.000
6	-0.023	0.057	31.558	0.000
7	-0.065	0.054	31.719	0.000
8	-0.076	-0.243	31.950	0.000
9	-0.083	0.035	32.243	0.000
10	-0.089	0.013	32.598	0.000
11	-0.094	0.066	33.026	0.001
12	-0.102	-0.144	33.566	0.001

Source: Author's data derived from correlogram of CoinDesk (2017b).