

Running head: PEER-TO-PEER DECENTRALIZED PLATFORMS

Peer-to-Peer Decentralized Social Media Platform Using Second-Layer Blockchain Technology

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Abstract

Current social media platforms built on specialized blockchains exist, but have failed to reach mainstream adoption. These decentralized alternatives have not been able to successfully migrate users from the existing offering of centralized platforms due in part to their decisions to create their own specialized currency and blockchain. This study proposes the idea of an algorithmically decentralized social media platform running via a second-layer extension of the blockchain as a solution that would alleviate the failures of previous blockchain iterations, and return social media to a peer-to-peer platform open to everyone as a way to dissipate knowledge, and provide services regardless of political constraints, borders, or personal beliefs. By analyzing this new technology, this thesis explores the opportunities and advantages that second-layer blockchain protocol solutions provide to address the vital concerns, and criticisms of the current internet while addressing which group of users are more likely to understand and favor them. Tweets were extracted and analyzed, finding that individuals are increasingly becoming interested in Bitcoin and second-layer technologies rather than dedicated and segregated projects that have been decreasing in online popularity. The study's geographic, historical, and economic analysis suggests that in order for decentralized social media platforms to stay truly decentralized and to reach mainstream adoption, they will need to integrate with the Bitcoin blockchain to build on the already established momentum. The second-layer solution being proposed by this study solves technological complications and increases the likelihood of mainstream adoption.

Chapter 1 : Introduction

Increasingly, social media users are worried about large corporations controlling the diffusion of information in the context of freedom of expression, and also the extent to which these companies control and safeguard user data. As is noted further in this study, over time, these centralized commercial platforms have become more restrictive towards the kind of content they allow on their respective networks. While users continue to put the blame on companies for exerting their power to restrict users, the inherent flaw and root cause of all of these platforms revolve around their centralization.

Centralized social media platforms, as we experience currently, are subject to political interference and economic persuasions which often leaves the most crucial part of the platform, the users, holding the metaphorical bag. Content creators on YouTube are limited in which political viewpoints they can present to their audience due to fear of demonetization and advertiser sensitivity, and Reddit users have also seen the platform depart from a mission statement promoting unfiltered speech to a platform that has increased the number of bans on specific self-moderated communities. For instance, the inherent flaw of centralized platforms and the types of political pressure they can receive was made clear when the government of Thailand decided to restrict its citizens' access to YouTube after a single video surfaced on the platform seemingly insulting the Thai King Bhumibol Adulyadej. As a result, in August 2007, YouTube agreed to censor all videos deemed to be offensive to the Thai government on an ongoing and rolling basis. This censorship was a direct result of political influence from the government, which led YouTube's parent company Google to consider the economic implication of their platform not operating in a country. Since YouTube is a centralized platform owned by the larger

conglomerate Google, YouTube's need to demonstrate profitability to its public shareholders trumped the need for a reliable source of unfiltered information for the citizens of Thailand.

These instances of censorship are only increasing because centralized platforms have to balance political sensitivities with economic fiscal responsibilities to shareholders. These centralized platforms will forever be subject to political pressure due to the inherent flaw that one corporation controls the network, and these platforms will always have to consistently transform their ideological belief for the economical benefit of shareholders.

Whether or not these acts of censorship lead to the Streisand effect is outside the scope of this study, however, the very question of it is a useful framework for this study to discuss and examine the consequences of consolidated centralized power as well as propose an alternative. To have a social platform truly independent in its internal operations while also being exempt from political influence, its foundation must be built on a decentralized protocol. This paper presents an opportunity to decentralize the section of the internet that needs it the most, social media platforms.

Before we can dive into decentralizing social media, the study first needs to understand the advantages surrounding being first to market. It is incredibly difficult to unseat a technology that has already fully occupied a space. However, if that technology fails and vacates the space, users will be striving to find an alternative. A decentralized social media platform that solely mimics its popular centralized alternative will inevitably have a hard time onboarding individuals if the wider consensus of users are still using the centralized platform. However, as individuals are increasingly growing tired of their primary sources of information being subject to political and economic censorship as well as their personal data being monetized without aware consent,

this study argues that there is an increasing likelihood of a breaking point among the community of users that will prompt a rise in popularity of decentralized social media networks.

Since Bitcoin is commonly referred to as sound money, and the parallel between decentralized social media platforms and the digital currency powering the underlying protocol is important to establish, the study argues that it is crucial to explore the field of economics to understand what constitutes a sound and unsound form of currency in hopes to draw similarities to social platforms. Being that sound money is defined by a lack of government interference which results in the rise of individualism and economic freedom, unsound money would be subject to economic and political manipulation by the few that weakens the influence of those who use it and need it the most. For instance, while gold has withstood the test of time and has provided its holders with a reliable and sound store of value, the bolivar has caused citizens of Venezuela an immense loss in purchasing power and influence. By this definition, decentralized social media networks that return power and ownership of data to its users could be regarded as sound, while centralized platforms that limit access and control would be unsound.

Drawing from the marvelous creation of hard money that is Bitcoin, I argue that the blockchain can power truly decentralized peer-to-peer social media platforms that the 20th century is in dire need of. The gains that come from decentralization, I argue, are compelling enough to justify the extra costs associated with running the network. While we know and understand that the current implementation of blockchain technology is not an efficient way to transact online, and is in fact immensely slower than centralized solutions, the second-layer has yet been studied or implemented for social media networks.

The advantage of eliminating the need to trust in third parties is crucial, as this will return social data back into the hands of individual users. The removal of large third-party

intermediaries such as Facebook, Twitter, and Google is of such paramount value to the end-user, that a platform built on the decentralized second-layer using the existing blockchain justifies any arguable increase in cost and loss of efficiency.

In an era where our personal data is the sole revenue stream for major technology companies, the argument can no longer be made that data is not worth being in our hands and in our hands alone. The financial cost associated with running a decentralized network for social media purposes is moot. These large corporations have consistently demonstrated not only a refusal or inability to safe keep our privacy and data, but have demonstrated that they hold no ethical obligations towards individualism and privacy as can be shown with recent data breaches and shameless profiting off of user data.

This is not at all to say that all centralized social media platforms must cease to exist, but they will need to find an alternative revenue stream - one that is not founded on the extraction and monetization of user data. While current social platforms that choose to create their own blockchain instead of opting for the decentralized second-layer running on top of Bitcoin currently exist in a prototype stage, they have not yet amassed a large market share of users because they cannot compete with current best practices in their respective space. On another note, while the Facebook created digital currency, the Libra, is not meant to decentralize their social media platform, once implemented, future research should study whether or not the move away from Bitcoin was beneficial for the company.

In this study, I would like to introduce the idea of running a decentralized social media platform running on top of the existing Bitcoin blockchain via a newly created alternative technological improvement, the second-layer solution, to address the dire consequences that are the rise in conglomeration, the loss of privacy in a digital era, the absence of a consensus ruled

platform, the lack of freedom of expression, and finally, the growing concern and practice of censorship. In order to do so, it is crucial for this study to determine if the world is ready for the decentralization of platforms, or put simply, if decentralized platforms are ready for mainstream user adoption. In order to answer the questions surrounding adoption, a comparison of the quantity of tweets that centralized platforms have over decentralized platforms was conducted.

This allowed the study to identify conversational trends for each platform and study month-over-month growths or declines in the overall quantity of discussion. Similarly, to identify the parts of the world that have a higher likelihood of adoption, geographic metadata associated with tweets were extracted, which allowed the study to indicate where decentralized platforms are already growing and which sociological factors may attribute to their popularity. Furthermore, a social network analysis methodology allowed the study to build on the sheer quantity of tweets to also indicate the degree to which the discussions occurred within a smaller community of like-minded individuals or a wider spanning community. Lastly, a sentiment analysis of the tweets surrounding the various topics meant that the study could make inferences as to how individuals were reacting to the distinct platforms. While a higher rate of negative tweets could point towards a growing distaste of how the platform is being operated, a lower rate of negativity would point to user satisfaction.

The first chapter of this thesis provides a background as to why the need for decentralized platforms is increasing. To do this, the chapter explores shortfalls the public has experienced from centralized conglomerates through case studies such as Cambridge Analytica, various data breaches, acts of censorship, privacy failures, and the notion of governance. Additionally, the chapter provides an overview of the currently existing decentralized platforms to provide readers with a general understanding of the current technological landscape. The second chapter

provides an overview and justification of the methods used to identify the likelihood of mainstream adoption of a decentralized peer-to-peer platform. Additionally, it lays out for the reader why specific terms were chosen for analysis as well as an explanation of technical Bitcoin terminology. The third chapter presents and discusses the results, namely, which platform has a higher likelihood of mainstream adoption, whether or not the decentralized platforms have amassed a consistently growing number of users discussing it on Twitter, the geographic trends in individuals discussing the terms, the overall online sentiment, and the network analysis structure. Lastly, a summary of the findings from the study are presented and areas of interest that future research should continue to explore are discussed.

Chapter 2 : Background and Literature Review

2.1 Background

In March of 2018, news broke that the now-defunct Cambridge Analytica had breached the data of 50 million Facebook users in a scandal that would alter public discourse about data privacy. Cambridge Analytica was a company built on uncovering user interests through data mining operations, using their built-in-house algorithms, and improperly obtained personal data.

In 2014, a Facebook application named “ThisIsYourDigitalLife” was created by University of Cambridge researcher Aleksandr Kogan, and subsequently downloaded by approximately 270,000 users across the world. Not only did the application gather personal data of its users, but it also collected information of contacts in the user’s friend network. The data collected through “ThisIsYourDigitalLife” ballooned to millions of profiles who did not explicitly give their personal profile access to the application. Aleksandr Kogan sold this data to Cambridge Analytica who then targeted user interests to sway their political opinions - a tactic known as psychographic profiling. This data breach not only marked a pivotal moment in data privacy as a fundamental human right, but acted as the catalyst for future data-privacy movements. With the testimony presented to the United States Congress by Facebook CEO Mark Zuckerberg in 2018, the conversation surrounding the centralization of power and the vast amount of information that the public provides to these large conglomerates propelled itself into public discourse. However, Cambridge Analytica was not the first, nor the only entity to demonstrate a lack of care or due diligence for user privacy. In 2013, email service Yahoo fell victim to a data breach resulting in the information of over 1 billion of its users being compromised. Data including email addresses, phone numbers, birthdates, security questions, and even passwords were stolen and initially sold to private buyers before eventually ending up on public darknet market sites for anyone to purchase. Even more startling, it took Yahoo three years to report the breach to its affected users. It remains up to speculation how a company could legally wait years before disclosing a data breach of this scale to its users. However, this deliberately delayed response set a precedent that caused an increase in not only the number of privacy activists, but an increase in the public’s knowledge regarding data ownership, online security, and privacy in the public sphere. On a similar note, in 2017, the servers of the credit reporting agency Equifax were breached resulting

in the theft of social security numbers, full names, and addresses of over 145 million individuals. Currently, it is still considered one of the largest data breaches in history.

Over the years, these breaches of personal information reinforced within the general public that trust was massively undervalued and abused by corporations that continuously conveyed the importance of safekeeping its users' information. Indeed, the notion of trust is commonly given to someone with whom you have a personal connection. We trust people who have the same background as us - and we trust people who have earned that trust based on past experiences. Trust is earned and constantly maintained within our social circles. However, when operating in a society with a larger number of individuals, new models of trust have had to be established in order to widen the social circle of participants.

In this new model, intermediaries such as Facebook and Twitter now act as our trusted third parties. When you send your friend a birthday message through a social media platform, you must rely on the platform itself to deliver the message. You no longer need to trust that your friend will receive the message, but trust in the intermediary to deliver it. This new model of trust is flawed; while it does prove to be a scalable method to ensure trust within large communities, it also gives all the power to these intermediaries, with evidently problematic consequences. After the 2008 financial collapse, large institutional banks lost their credibility and trustworthiness in the eyes of the public. More recently in 2018, the government of Venezuela lost the trust of its citizens after the re-election of Nicolas Maduro. All this to say, the power given to these intermediaries can lead the way into corruption and abuse of power. Cognitive bias aside, why do we continue to put our trust in corporations that have shown negligence towards our private information time and time again?

There was a time where social media's role in society was transparent and straightforward, or at least such was early social media rhetoric. Initially built as a way to connect individuals, Facebook established itself as a lighthearted platform where friends can connect, and where family members could remain in touch. While I am not arguing that a company's initial mandate cannot shift throughout the years, I am contending that some of Facebook's changes transformed the platform to one that some believe no longer serves in their best interest. For instance, then-candidate Elizabeth Warren had her Facebook advertisements removed when she called for the breakup of Facebook and large tech conglomerates in 2019 (Kelly, 2019). Social networks have ingrained themselves into many facets of our daily lives. Presumably, these social networks were involved in the most recent planning of your friend's party, or the last time your work colleagues scheduled a get-together. Identifying the vast reach that these centralized platforms have in our day to day affairs is important because a problem must always precede a solution. As such, social media platforms are a useful tool that can enhance social connection, but only when divorced from the problems of centralized conglomerates.

Therefore, before proposing the need for an alternative decentralized platform, understanding what is wrong with the current platform guides this research to address not only the technological obstacles in building this proposed solution, but the ever more important societal impacts that these platforms have been causing. Frankly, I am not sure that social media can go back to a simplistic and uncomplicated involvement in our lives. However, if we were in fact truly happier with that kind of relationship, then the attempt to return to what was once seen as a societal benefit as opposed to a societal obligation is more important than ever. After all, the technology now exists to propose such an attempt.

Today, in 2020, while the erosion of public trust is currently underway by large conglomerates such as Facebook and Google, what better time for me to propose an alternative that not only addresses the scalability needed to function within a broader public, but completely removes the power given to the intermediary. Ironically, this paper also comes at a time where Facebook decided to release its whitepaper concerning the creation of its own digital currency named “Libra”¹. Nonetheless, just like how AOL and MSN introduced a billion users to a restricted internet that inevitably failed, the Libra will arguably do the same in the digital currency space because end users now possess knowledge about how their personal data can be exploited, and their access to information censored.

The erosion of public trust is why the return to peer-to-peer decentralized platforms is more important than ever, and will prove to be of significance to the social media landscape.

I propose an algorithmically decentralized social media platform running via a second-layer extension of the blockchain as a solution that would return social media to a peer-to-peer platform open to everyone as a way to dissipate knowledge, and provide services regardless of political constraints, borders, or personal beliefs.

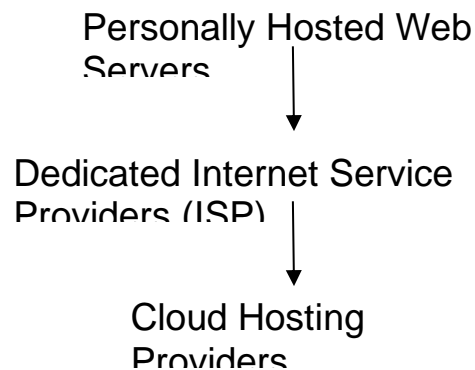
To its credit, the ideological belief of a decentralized web was always present. During the internet’s infancy in 1993, large internet service providers (ISPs) like AOL, Prodigy, and MSN accounted for less than 50% of all web traffic. At that time, internet users were primarily hosting their own web servers to access the services and content they desired. Interestingly enough, this meant that the majority of internet users were able to fulfill the services they required without having to rely on a middleman to connect them. Over time, the convenience and simplicity that

¹ Libra White Paper: Blockchain, Association, Reserve
<https://libra.org/en-US/white-paper/>

centralized platforms provided bolstered their market dominance in the internet space leading to the inevitable rise of cloud hosting providers. Figure 1 outlines the shift in how individuals accessed the internet.

Figure 1

Chronological Transformations in Accessing the Internet



The current state of the internet promises a problematic, limited future for its users. Since the emergence of the participatory internet, or web 2.0, ideas surrounding centralized governance, privacy, and censorship of content on web platforms have become increasingly important to study because a new technological solution to address the internet's current limitations is needed. To suggest its next logical progression, I aim to fill the gap in literature surrounding second-layer solutions, and provide a set of meaningful observations and recommendations for future research into decentralized social media platforms. The peer-to-peer currency created on the blockchain, Bitcoin, represents a cryptographic model to counter internet censorship, which leads to improved individual privacy and increases personal control and ownership of data. By analyzing this new technology, this thesis will explore the opportunities and advantages that second-layer blockchain protocol solutions (e.g. Lightning Network) provide to address the vital concerns, and criticisms of the current internet while addressing which group of users are more likely to understand and favor them. Furthermore, determining whether or not

decentralized second-layer alternatives are ready for user adoption will be studied in order to identify the current state of the field, and to provide a set of meaningful recommendations to support the technology's further development. Figure 2 provides an overview of major terms being discussed throughout this paper.

Figure 2

Blockchain Terminology

<i>Term</i>	<i>Definition</i>
<i>Blockchain</i>	<i>A public record of Bitcoin transactions</i>
<i>Bitcoin</i>	<i>The digital currency running on the Blockchain</i>
<i>Peer-to-Peer (P2P)</i>	<i>A system as an organized collective allowing individual users to interact directly to one another without a mediator</i>
<i>Decentralized / Decentralization</i>	<i>The absence of an entity that governs the network</i>
<i>Halving</i>	<i>The decrease of issuance of block rewards</i>
<i>SegWit (Segregated Witness)</i>	<i>A technological improvement to decrease network fees in each transaction and increase each block size by removing signature data</i>

2.2 Overview of the Second-Layer and SegWit

Bitcoin today is certainly not like Bitcoin was back in its inception. As more and more individuals onboard onto the network, the pace at which new efficiencies get proposed to the network increases. Towards the end of 2015, the introduction of a technological proposal set to establish time functions within Bitcoin transactions was introduced. In other words, it was the ability to select specifically when a transaction was to be executed on the Bitcoin blockchain

(Todd, 2014). In development terms, this is called *check log time verify*. While at first glance, this proposal may not seem to be of important significance to a network that has been already operating successfully, but it opened a whole new dimension into how the blockchain can be utilized for various other purposes and applications besides its function as money. As of the time of writing, most people have not yet noticed the significant impact this technological improvement will have not only on the Bitcoin blockchain, but on the digital landscape as a whole.

One of the first applications of this newly established *check log time verify* function is what is referred to in this paper as a second-layer, but more technically referred to as *state channels*. This section will briefly set out to describe the second-layer in order to provide a contextual anchor to future conversation topics. To begin, the second-layer allows the creation of bi-directional payment channels which allows individuals to conduct transactions amongst one another without broadcasting that transaction to the underlying Bitcoin blockchain. Essentially, these are transactions that have a time dimension as to when they are to be broadcasted to the blockchain. Think of it as exchanging IOU's between friends before eventually deciding to settle the debt physically. While you are still keeping track of how much money one friend owes another, the settlement of the debt can be paid at a later date and at a later time. Additionally, the amount of transactions needed to create this bi-directional payment channel is limited:

In the entire lifetime of the channel, only two transactions need to be submitted for mining on the blockchain: the funding and settlement transactions. In between these two states, the two parties can exchange any number of commitment transactions that are never seen by anyone else, nor submitted to the blockchain. (Antonopoulos, 2017, p. 301)

However, even better than promises between friends, the state channel can ensure that transactions between two or more individuals are cryptographically written and secured. Figure 3 is a snippet of a digital contract that makes use of the aforementioned state channel.

Figure 3

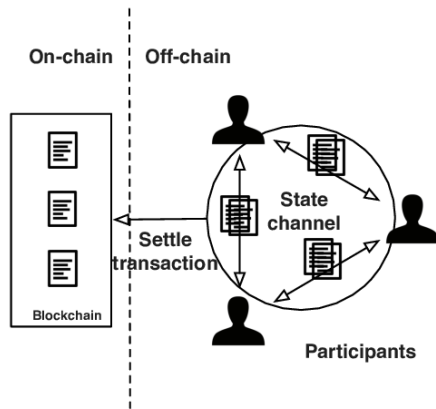
Payment Channel Created Between Two Parties

```
HASH160 <revokehash> EQUAL
      IF
      <Bob's pubkey>
      ELSE
      "24h" CHECKSEQUENCEVERIFY DROP
      <Alice's pubkey>
      ENDIF
CHECKSIG
```

After individuals are finished with their transactions amongst one another, only then does the final tally get written to the actual Bitcoin blockchain. For example, if Bob decided to send 50 separate transactions worth \$1 to Alice, and both parties decided to settle their bi-directional payment channel, only one transaction would be written to the Bitcoin blockchain that states that Alice now has \$50, and Bob has \$50 less. With these types of payment channels, there is no need to broadcast every single transaction, only the settlement transaction. Figure 4 maps out how smaller transactions between participants are combined into larger settlement transactions that are broadcasted to the blockchain.

Figure 4

Payment Channel Illustrating Types of Transactions



This process leads to great efficiencies, and opens the door for applications to be built using this new technology while still having the benefit of using the Bitcoin blockchain.

Additionally, this introduces the feasibility of micropayments to the Bitcoin blockchain. Since there are no fees in transacting within a bi-directional payment channel, payments within parties can be as little as 1/265th of a penny and transacted instantly because they are not yet written to the underlying blockchain. The second-layer solution also contains other benefits worth exploring. Since every connection on the network is encrypted, it is virtually impossible to decipher where the transaction originated from beyond who you opened a channel with. This massively increases the privacy of the network and anonymity for its users.

However, the transactions themselves do not have to be in a monetary form such as dollars, but can instead contain information bits. The transaction itself between parties can be a digital string of text, such as a social media post. Indeed, if someone were to publish multiple blog posts to the network using the second-layer, the posts themselves would be available within milliseconds, but would not be archived within the Bitcoin blockchain until the individual decides to settle the group of posts into one with a settlement transaction. When you are not transacting with money, it is arguably less important to have your transaction immediately broadcasted to the network and verified. Unless you are waiting on an important payment to go

through, transacting on the second-layer provides more than enough advantages to make it worthwhile. This is why, I argue, that the possibility of running a decentralized social media network with the newly proposed state channel is a possibility worth delving into deeper.

There is analogue to this process in contemporary payroll systems. Consider: why does the average Canadian get compensated for their work on a bi-weekly basis? This is a topic that is rarely considered, but worth further discussion to link the proposed second-layer solution to the current financial infrastructure. Why then, is money merged into larger paychecks that are then deposited to your bank on bi-weekly intervals? The answer is quite simple, it is a matter of efficiency. The more transactions going through your account, the more expensive it is for the banking system to handle the requests. For the same reason then, it makes more sense for the Bitcoin blockchain to adopt an efficient method for merging smaller transactions into one much larger transaction that is then published.

The term ‘SegWit’ refers to the technical change in the Bitcoin network architecture for transactions that allows payment signatures to be in an independent attached data structure. This separation allows payment transactions to be lower in its total memory size which in turn lowers the fee needed to send transactions. As a point of reference, Figure 5 visualises the increased space efficiency of adopting SegWit.

Figure 5

Block Size Effects With and Without SegWit

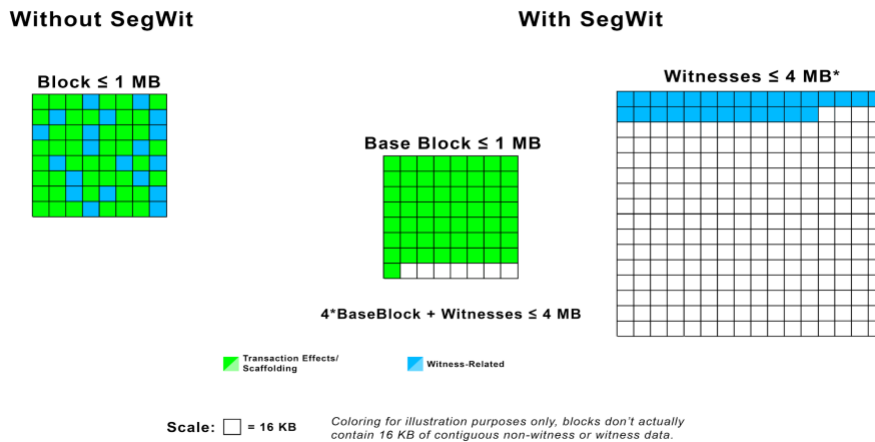


Figure 5. Chart from Veriblock's recent Medium blog post. <https://medium.com/@veriblock/veriblock-adopts-segwit-and-will-now-take-more-space-on-bitcoin-edf11fbb6678>

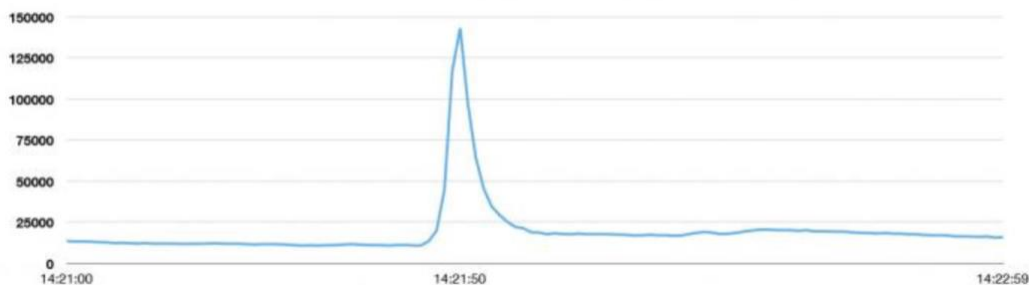
2.3 Alternative Platforms

This section will focus on identifying and exploring established social network platforms that run on a decentralized blockchain. While there are currently no platforms utilizing a second-layer solution, understanding the approaches that have already been conducted can lay the foundation towards a new conceptualization that solves the complications leading to user adoption, and will lead this paper to fill a gap in the current state of the decentralized web. With that being said, there are primarily two varying perspectives that come with building decentralized alternatives that both need to be understood. To begin, it is important to note that when dealing with blockchain infrastructure, understanding the purpose of what the tool will be built for is crucial. Most argue that building their own custom underlying blockchain is the best approach since it allows a way to tailor it to their needed use-case and specifications. For instance, a platform requiring very few writing and validation functions could get away with slower block generation times - think of archiving platforms like publication databases and government online information records. For platforms like these, the validation and integrity of the data written to the blockchain take precedence over its speediness - meaning that Bitcoin's

block generation time of approximately ten minutes is more than suitable. However, some platforms have a large volume of transactions to process in a very short amount of time. As a result, the speed in which the platform can handle requests often takes precedence over its security and its degree of immutability. For example, a social network like Twitter needs to rely on infrastructure that can process a large amount of transactions per second. Transactions, in this case, can correspond to individual tweets being published to the platform by individuals. To illustrate this point, on August 3rd, 2013, Twitter reached a one-second transaction peak of 143,199 tweets per second without being subject to any technical complications or slowdowns. The technical throughput capabilities of Twitter can be visualized in Figure 6.

Figure 6

Volume of Twitter Posts per Second



Only now does Bitcoin's theoretical maximum of seven transactions per second start to become problematic. For a platform like Twitter whose main focus is on the distribution of timely content and information, the speed of the infrastructure running the platform takes precedence over its ability to be immutable and irreversible. With that being said, in its current form, the Bitcoin blockchain would not be able to process Twitter's current stream of data points to serve its users who expect real-time access to information.

On the topic of Bitcoin's transactional capacity and limitations, it is important to note that this is a point of contestation within the broader community due to the increasing popularity and usage of the blockchain. Commonly referred to as the block size or scaling debate, the communities' ideological belief surrounding Bitcoin's ability to scale with the increase in user acceptance started to split into two different camps. On one hand, some argue that the proper way to scale the blockchain is to alter its programming code to increase the size of every block which would theoretically allow a larger number of transactions to be written to the blockchain. Notable supporters of this argument include former Bitcoin code contributor Gavin Andresen who published an open letter in May of 2015 citing the urgent need to increase the maximum block size. In his letter, he writes that "if the number of transactions waiting gets large enough, the end result will be an over-saturated network, busy doing nothing productive" (Andreson, 2015).

This modification, in theory, would increase the transactional capacity of the network and allow for faster transactions. On the other hand, others in the community argue that investing resources into building alternative scaling proposals that run on top of the unmodified underlying blockchain such as the lightning network and the implementation of segregated witness addresses could have far better implications for the future growth of the network. Notably, Bitcoin educator Andreas Antonopolous and cited author of the original Bitcoin whitepaper, Adam Black both supported investment in proper second-layer scaling solutions instead of increasing the size of each block indefinitely. Specifically, Black noted Bitcoin's technological edge due to the infrastructure produced by second-layer solutions while Antonopolous raised the concern that the network becomes less decentralized the higher the block size becomes.

This debate can be summarized by one camp arguing for the building of a more efficient network versus the other camp advocating for building a larger network. In the end, the network consensus rejected increasing the size of each block, and as a result, scaling solutions that improve the network's efficiency began to be built.

However, the fact that Bitcoin was programmed to be decentralized since its inception makes the notion of consensus an 'everyone together' or 'not at all' proposition. In fact, since this was the first major ideological debate within the community, it reinforced for many Bitcoin's truly decentralized nature. It is an illusion that one party controls Bitcoin, and previous to this event, some community members appeared to have a lot of power in the decision-making process of Bitcoin because they continued to suggest developments to the protocol in ways that the consensus agreed with. Nevertheless, only when community members stop serving that consensus did the appearance of power dissolve. To summarize, this conversation happening within the community is important to note because it provides context as to why second-layer solutions were proposed in the first place as a scaling solution, and what problems it set out to solve.

2.4 Decentralized Platform : BitTube - An Alternative to YouTube

Built as a decentralized version of the popular video-sharing platform YouTube, BitTube has two main goals. To begin, due to the increased amount of censorship of content we see today on current platforms, BitTube proposes a platform built on top of the InterPlanetary File System (IPFS) protocol which allows the storage of video files to be hosted and shared via a peer-to-peer network. This means that unlike YouTube, videos uploaded to BitTube are never centrally stored on any servers. While this storage method ensures that the videos themselves could not be in trouble of being censored by a central authority, it does leave the web hosting of the platform

itself as a single point of failure. For instance, BitTube itself as a website is hosted by traditional internet services - meaning that the website could theoretically go down at any time if the hosting provider chooses to do so. A potential solution for this would be to register for a DNS (Domain Name System) built on top of the decentralized web. However, at the time of writing, the platform has not registered for this alternative and thus remains at risk.

Technical complications aside, BitTube is remarkable for its successful implementation of decentralized video content, and how it migrated from a revenue model based on advertisements to a model based on airtime. To elaborate, while YouTube relies on its optional service of Google AdSense to display advertisements to viewers in order to compensate content creators, BitTube created its own cryptocurrency which is rewarded to content creators depending on how long a viewer is watching their content for. The longer a viewer is tuned in for, the more cryptocurrency the content creator ends up receiving. This new way of rewarding content creators is needed in a constantly evolving digital landscape where internet ad blocker use is on the rise - which means that content creators need to rely on additional streams of revenue to sustain their production. In fact, according to research conducted in the United States, usage of ad blockers has reached 27 percent of internet users (Guttmann, 2019).

On a final note, BitTube was established at a time where two major issues were at the heart of YouTube. Firstly, content creators on YouTube were, and still are, striving for additional streams of revenue as the reliability of Google AdSense continues to drastically change. In 2019, YouTube announced that videos created for children will no longer be able to hold personalized advertisements. Since the majority of advertisers run personalized ads, children-oriented content creators will be subject to a substantial drop in their revenue. While this policy change only

targets a percentage of its overall content creators, it leads to the increase of financial uncertainty for its creators.

Furthermore, this upcoming change has spurred additional concern amongst all content creators because it has opened their eyes as to how much influence a third party holds to their livelihood. The second, and most frightening issue, was the controversy regarding demonetization. This has to be, within the YouTube community, one of the biggest areas of concern regarding their individual financial sustainability. In March of 2017, YouTube published an article outlining new policies regarding advertiser-friendly content and changes as to what types of content can be monetized². This announcement led to unprepared content creators losing upwards of approximately half (50%) of their total take-home income as reported by New York Magazine in 2017³.

In short, in the first week of April 2017, a substantial amount of content creators saw their video advertising revenue decline significantly. Since YouTube's new policy allowed advertisers to opt-out of advertising on specific videos and specific kinds of video, many major content creators were hit with the revenue decline. Individuals, for instance, who reported on the news which happened to include a tragic event were not deemed as advertiser-friendly anymore. Similarly, content creators who used profanity in their language were also demonetized. As was previously mentioned, creators were now looking for additional streams of income to make up for lost video advertisement revenue. Many have decided to create a fundraising campaign via the service GoFundMe in order to allow their viewers a way to chip in a desired monthly amount while others have relied on selling branded merchandise such as clothing.

² <https://youtube-creators.googleblog.com/2017/03/strengthening-youtube-for-advertisers.html>

³ <https://nymag.com/intelligencer/2017/12/can-youtube-survive-the-adpocalypse.html>

Keeping in mind that all of these changes are happening to the video platform that has the biggest overall market share, BitTube was positioned to fill the current market need. However, while it filled the technological requirements to provide a decentralized alternative, it failed to onboard a substantial amount of users. Without a large pool of video content being uploaded to the platform, the desire for content consumers to visit BitTube dwindled. During its high in 2018, the currency powering the platform reached \$0.45 USD. As of today, the currency is currently valued at \$0.01 USD (15/09/19). To sum it up, content creators cannot invest in producing content on a platform with a low amount of active users, and content consumers have no interest in visiting a platform with a low amount of video content - a classic chicken and egg situation.

The question remains to be asked: would BitTube have benefited from the implementation of a second-layer solution instead of choosing to run its own blockchain?

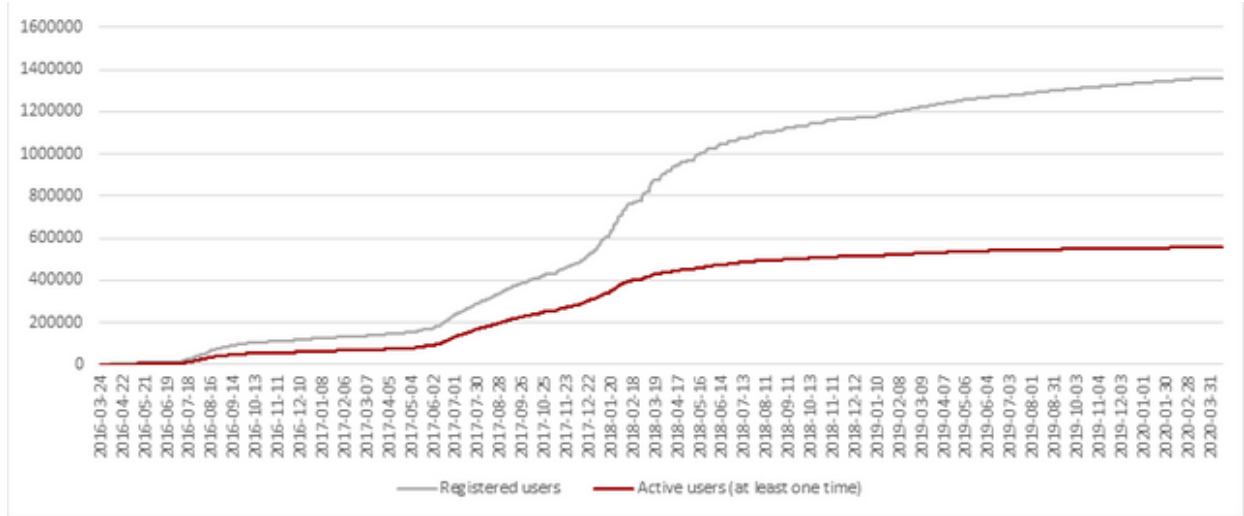
2.5 Decentralized Platform : Steemit - An Alternative to Reddit

With over one million registered users, Steemit is considered to be one of the largest decentralized social media networks. Built as an alternative to popular discussion boards such as Reddit, Steemit was built on top of its own blockchain and utilizes its own native digital currency called “Steem”. As users post and contribute information to the network for others to digest, they are incentivized by being rewarded in the digital currency. According to the platform whitepaper published in 2018: “an important key to inspiring participation in any community, currency or free-market economy is a fair accounting system that consistently reflects each person’s contribution [and] Steem is the first cryptocurrency that attempts to accurately and transparently reward an unbounded number of individuals who make subjective contributions to its community” (Steem, 2018). Similarly to BitTube, Steemit decides to directly compensate their users who produce content with their own currency instead of having to rely on third-party

advertisements. In fact, the removal of third party influence from social platforms is a key pillar as to why these decentralized platforms get built in the first place. Removing power from central authorities such as advertisers and empowering individuals through direct compensation could potentially lead to an increase in user participation and fulfillment. Additionally, since individuals do not have to worry about whether or not their content is at risk of censorship, they are able to converse in an unfiltered way without fear of demonetization by an advertiser. While this theoretically would lead the platform towards conversations that are more representative of public opinion, some critics argue that decentralized platforms, like Steemit, become host to a slew of alt-right individuals who take advantage of the uncensorable nature of the platform to spur hateful conversations.

Regardless, while Steemit has been able to amass an impressive amount of registered users - far outpacing other decentralized platforms, its growth rate has stagnated as individuals do not return to the platform and do not consistently contribute to the community ecosystem. Contribution to the ecosystem could be by posting their own content, commenting on the content of others, or assigning ratings to the content they come across. The rate of new registrations to the Steemit platform and growth rate of active users are shown in Figure 7.

Figure 7

Steemit Number of New Registered Users and Active Users (Per Month)

The cryptocurrency that Steemit uses to incentivize individuals to create content on the platform is currently valued at \$0.15 USD per Steem (15/09/15). At its all-time high in January of 2018, Steem was valued at \$8.57 USD. This means that the value of people's content production has been devalued by 98 percent. While volatility in the digital currency market is nothing new, the decrease in Steem's price can point to uncertainty for the future of the platform.

With that being said, while Steemit has yet to come close to the market share of similar centralized discussion boards, its growth and initial launch should be further analyzed to identify how it successfully capitalized on its first-mover advantage, and how it captured the interest of users. When the platform initially launched, the landscape for blockchain-based social networks was minimal. There were no decentralized alternatives to discussion boards, and centralized platforms like Reddit were in the middle of multiple controversies regarding censorship of content. Moderators of centralized discussion boards were, and still are, actively removing content that goes against the established terms of service. Yet, these moderators also wielded the power to additionally remove content that went against their own established viewpoints. As a result, this led to a substantial political and ideological divide that propped up non-censorable

alternatives like Steemit. While I am not attributing Steemit's sole success to good political timing, I am arguing that it played a major role in the initial rise of its user base. With an overview of some decentralized alternatives conducted, the thesis moves towards the discussion of the broader notion surrounding major themes such as censorship in order to set the historical and theoretical foundation as to why the emergence of decentralized alternatives is important to study.

2.6 Literature Review : Censorship

Recent research on internet censorship has primarily focused on three main phenomena: political suppression of opposing ideas, policing of culturally determined content, and commercial attempts to enhance economic development. In their assessment of the state of censorship on the internet, Erixon et al. (2009) suggested that motivations that lead to censorship on the web do not significantly differ from censorship of other types of media such as television or film, and that the omnipresent method to censor and regulate content online is blocking specific webpages outright. Indeed, in their study of deletion practices in Chinese social media, Bamman et al. (2012) indicate that in addition to blacklisting specific webpages, networking filtering techniques such as keyword detection are widely used in the context of the Great Firewall of China (GFW) as a censorship technique.

Increasingly, however, alternative methods of censorship such as information friction and flooding are emerging to provide governments with more politically palatable options to limit access to information. According to Roberts (2018), friction :

impose[s] small or large taxes on information; it can impose very small costs in terms of time and money or can make information very difficult to find [and] for those with little time, patience, or resources, even small frictions [...] can have significant effects on

whether citizens consume particular types of information or whether the media will collect particular types of data. (Roberts, 2018, p.56-58)

On a similar note, information flooding is described as the “promotion of information, which changes the relative costs of access by making competing information cheaper and off-limits information relatively more expensive” (Roberts, 2018, p.193). In short, these alternative techniques decrease the ease of access to censored media and increase the ease of access to permissible media to influence and limit online behaviors. Because these techniques resemble a softer stance on censorship than blocking websites, they are becoming increasingly common.

The literature surrounding internet censorship provides insight into the techniques used to curb freedom of expression and access to information, but a limited number of studies also explore how users circumvent this restriction beyond soft fixes such as the use of virtual private networks (VPN). The introduction of new technological innovations such as the blockchain has been accompanied by the rhetoric that censorship-free information can be accessed regardless of geographic location, creating a true borderless communication network that can be used to propagate information.

According to Mattila (2016), the introduction of blockchain technology has disrupted society by providing a digital platform that is “disintermediated, censorship-resistant and tamper-proof” (Mattila, 2016, p.5). As a case study, OpenBazaar, the online distributed free marketplace running on blockchain technology, demonstrates that because the network operates in a distributed fashion and without an intermediary, no individuals or entities can censor the viewing, purchasing, selling, or transaction capabilities of the network. Such a marketplace cannot be created without blockchain technology, and the system can be accessed regardless of geographic restrictions due to its peer-to-peer nature. Similarly to Mattila, Kewell et al. (2017)

stress the importance of a truly permissionless blockchain to achieve censorship resistance and immutability of information, but also note that permissioned and private blockchains can be faster and more efficient because only selectively chosen parties can write to the chain.

As Neisse et al. state in their research, the transaction capacity of the Bitcoin network “has a theoretical limit of 7 transactions per second (tx/s) but usually reaches on average only 3 tx/s [...] this throughput is clearly not enough with the number of Facebook-like service providers currently being used” (Neisse et al. 2017, p.5). These technological limitations are frequently cited as barriers to open and public blockchains. According to Yli-Huuno et al., blockchain technology has transformative potential, but “suffers from technological limitations and challenges” (Yli-Huuno et al. 2016, p.4). For example, in addition to technological barriers, political pressure can shape blockchain adoption and use. Surely, with the introduction of the blockchain, the ongoing censorship game of whack-a-mole cannot be won by any technical means. However, Campbell-Verdyn (2018) argue that the censorship battle could be won by political interference if regulations are imposed upon the network and its active participants. Indeed, since countries such as Russia, the United States, and China all have different approaches to regulating this new technology, the blockchain has the possibility of being hindered which would limit its growth. The literature indicates that the existence of this regulation suggests that a truly public and permissionless blockchain is needed to circumvent internet censorship around the globe, but due to technological constraints, including speed limitations, scalability, and political interference from governing authorities, an alternative solution built upon blockchain requires additional study.

2.7 Literature Review : Privacy

Individuals have often longed to employ cryptographic techniques to obfuscate information being transmitted, that is, to ensure the original message remains hidden from unauthorized individuals, and to prevent any alterations when transmitting from sender to receiver (Gelbstein & Kamal, 2002). With the rise of technological complexity in cryptography due in part to Claude E. Shannon's mathematical theory of communication known as information theory, individuals now have access to robust and accessible end-to-end encryption applications to ensure their privacy. According to studies on messaging traffic over the internet, the amount of messages being sent daily is set to increase more than 20 percent throughout 2019, which equates to approximately 274 billion messages per day (Lewis & al, 2017). Furthermore, three of the most used messaging applications—Facebook, WhatsApp, and Viber—have moved to an end-to-end encrypted model (E2EE) which demonstrates a trend that responds to consumer privacy concerns.

2.8 Literature Review : Governance

Blockchain technology has been used to bring into question how the traditional role of government institutions and the existing political system can be replaced with decentralized governance and mathematically proven consensus. Generally speaking, the blockchain enthusiasts that advocate for a decentralized consensus model fail to understand the value proposition of traditional hierarchical mechanisms and notice its inefficiencies in governance (Paquet & Wilson, 2015, p.21).

Individuals involved in blockchain governance have various different philosophical beliefs. In fact, “many enthusiasts simply promote the blockchain as a more efficient, decentralized and consensus-driven public repository, which can have a number of applications in order to make citizens less dependent on governments, yet within a society that is ultimately

founded upon the State authority” (Atzori, 2015, p.4). However, some individuals hold extremist positions and regard the State as “illegitimate, unnecessary and irremediably obsolete depository of power, and they openly encourage the use of the new information technology as a liberating force against the very concept of authority” (Atzori, 2015, p.4). Decentralized online platforms are able to solve ‘hold up’ problems found in centralized applications which can in return reduce the potential for under-investment since “network members can always refuse to introduce any changes” (Arrunada and Garicano, 2018, p.2). Despite that, the introduction of decentralized governance to online platforms increases problems related to symbiosis, consensus, and incentivizing because every individual on the platform has voting and veto power. According to Arrunada and Garicano, this “poses a problem for changes that are not win-win, that is, any change which is good for the whole network but causes losses to some players. Decentralized platforms will find this type of change hard to implement” (Arrunada and Garicano, 2018, p.2).

Since the notion of an algorithmic governance model coincides with full transparency of the inner workings of an organization, scholars argue that the blockchain would have “remarkable effects on the behavior of players such as managers, investors, and shareholder activists” (Piazza, 2017, p.290). Currently, the U.S. Securities and Exchange Commission requires publicly traded companies to disclose their finances including employee executive compensations. Piazza argues that the introduction of blockchain technology in the governance structure would render this information easily parsable for the general public to view and verify. Another advantage to blockchain-based governance is the transition from a universal offering of services to a consumer-based transactional model of government services. In fact, “governments could shift from being the forced one-size-fits-all ‘greater good’ model at present to one that can

be tailored to the needs of individuals. Imagine a world of government services as individualized as Starbucks coffee orders” (Swan, 2015, p.46).

Critics argue that blockchain suffers from technical problems and a lack of feasibility. However, a second-layer solution like the Lightning Network built upon the pre-established blockchain would resolve many of those drawbacks. Even though the idea and creation of a decentralized network presents itself as the logical progression to society and the internet, “it will take time for the idea of decentralized trust through computation to become a part of mainstream consciousness, and until then, the idea creates cognitive dissonance for those accustomed to centralized trust systems” (Antonopoulos, 2014). The lack of literature surrounding second layer solutions presents an opportunity for this study to address how the technology can overcome issues of scalability, speed, and decentralization to tackle themes of censorship and governance.

2.9 Conceptual Framework

The study will be conducted by way of content analysis, network analysis, and sentiment analysis because it offers a few considerable advantages. Notably, an online ethnography can be used in conjunction with sentiment analysis tools to gauge if the conversations happening on specific social media platforms tend to be positive, neutral, or negative. Indeed, according to qualitative researchers, these types of studies are in fact based “on the premise that gaining knowledge about humans is impossible without describing the human experience as it is lived and as it is defined by the actors themselves” (Polit & Hungler, 1995, p. 517).

A content analysis on Twitter was used to identify whether or not decentralized platforms, in their current state, are ready for mainstream user adoption. A comparison of individuals discussing topics related to YouTube and Reddit is compared to their decentralized alternatives BitTube and Steemit. Additionally, an analysis of Twitter conversations regarding

second-layer technologies and technical terms (including terms such as ‘SegWit’, the technical change in the Bitcoin network architecture for transactions that allows payment signatures to be in an independent attached data structure). This separation allows payment transactions to be lower in its total memory size which in turn lowers the fee needed to send transactions. This content analysis is used to identify the current conversational trends within the community. Steven Kleinknecht (2003) used and refined this method, and it will serve as a base for the current study as a way to understand how different demographics engage in conversation topics about the fundamentals of blockchain technology, sentiment, and openness to decentralized alternatives. Since each social media platform will have a different user demographic, this method will allow the study to gather and document responses and behaviors while maintaining the contextual landscape of the platform itself.

During the online content analysis, it was important to keep in mind the varying aspects of social influence, that is, the degree in which individuals align their beliefs with that of the collective group. In fact, according to studies conducted, the strength of groupthink influence is dependent on whether or not the group is made up of friends, or complete strangers (Hui & Bechegger, 2009).

Furthermore, an online content analysis was selected for this study in order to conduct unobtrusive research into the online behaviors of the Bitcoin community on Twitter and to transform a large amount of Twitter posts into a concise summary of key findings. This was crucial to analyze and understand how the two groups communicate and reference second-layer solutions without prompt or interference. Indeed, in order to test the hypotheses of Twitter message characteristics, it is important to observe users in their natural environment and to limit the possible inclusion of researcher bias and leading questions. In order for this study to truly

capture whether or not second-layer blockchain solutions are ready for mainstream use - or are even included in the online conversation as a whole, the study needs to refrain from artificial discussion created by the researcher. Instead, careful analysis and examination of the naturally producing exchanges over a long period of time is the most appropriate research strategy. On a similar note, since the coding unit of sentiment analysis discussed previously is not open to interpretation, a content analysis is a reliable way to analyze the Twitter qualitative data. As a result, this research strategy can be applied at a later date with a new set of Twitter data without compromising the research validity.

Comparatively, a questionnaire could have been produced and sent to a Bitcoin-related online community. However, the results can be biased by inappropriate phrasing and by the placement of certain questions. For instance, by probing respondents into thinking about second-layer solutions, the results of the study would fail to address whether or not the new technology is already a part of the online organic conversation. Similarly, conducting in-person interviews would not be able to address the wider online community as a whole, and would fail to be generalizable and replicable in future studies. As a consequence of these limitations, an online content analysis utilizing a large real-world archive of public tweets mentioning specifically chosen keywords is the most suitable research strategy given that it is able to conduct an unobtrusive analysis and observation of the natural and organic discussion surrounding Bitcoin-related technologies.

In short, the content analysis will serve as a way to determine how distinct demographics with varying degrees of technical knowledge engage in conversations surrounding second layer decentralized platforms.

2.10 Sentiment: Valence Aware Dictionary and Sentiment Reasoner (VADER)

The sentiment analysis tool VADER will be used to parse through conversations on Twitter because of its specialty in analyzing text within online communities. According to researchers, the internet has “made it possible to find out about the opinions and experiences of those in the vast pool of people that are neither out personal acquaintances nor well-known professional critics - that is, people we have never heard of” (Pang & Lee, 2008). Indeed, the study and analysis of groups using sentiment analysis techniques have shown to be especially effective for large datasets such as social media websites. Furthermore, VADER will allow the study to extract and analyze the varying degrees of emotional responses in regards to decentralized platforms while recognizing the importance of context in the vocabulary used in different social media platforms. In essence, the use of punctuation, slang, emoticons, and utf-8 encoded emojis will be taken into account for the sentiment analysis.

2.11 Discussion and Rationale

The research being conducted is important because while there are currently available decentralized alternatives to popular social media platforms, none of them have decided to implement an infrastructure based on the second-layer. As was explored in the analysis of alternatives, while BitTube and Steemit were able to fulfill their technical goals and provide a working platform, the specific digital currency issued on each of their blockchains has suffered considerably. This led to the reduction of compensation being paid out to content creators, and a decline of the usage on the platform itself. These platforms were not built on the Bitcoin blockchain because of the technical requirements both in speed and flexibility, but if they were, these platforms would have been able to issue Bitcoin in compensation instead of their own

created currency. This would have led to an increase in interest for content creators who would have been paid in the world's largest digital currency, instead of coins that have seen significant declines in value. This, I argue, is the problem surrounding the current landscape of decentralized alternatives. If the platforms want to spearhead the movement to ensure fair compensation without relying on individual third parties, then they need to stray away from issuing currencies on their own blockchain which have little to no monetary value - and need to migrate to issuing Bitcoin which has proven itself to be a better digital store of value.

The reason why these platforms choose not to build on the Bitcoin blockchain is because of speed and flexibility limitations, both of which are solved by conforming to the proposed alternative of the second-layer. This in turn would allow platforms to build on top of the Bitcoin blockchain with the speed and efficiency needed while solving the major hurdle of providing a reliable method of compensation that is preventing these platforms from reaching mass user adoption. Lastly, addressing the research question surrounding how individuals engage in conversations online regarding blockchain can serve to provide additional guidance as to how a decentralized platform running on the second-layer can be successful in hitting mass user adoption.

Chapter 3 Research Design and Methodology

In the following chapter, I will cover the utilization of a Twitter content analysis methodology to unearth the readiness of second-layer solutions, outline the procedures adopted in order to gather and analyze public data and provide insight as to why the employed research design was best suited to address the central thesis.

Since Twitter is a generally accepted platform for casual and unfiltered conversations that require little to no self-monitoring, studies using the platform can analyze conversational trends as to what individuals choose to discuss and broadcast to their respective networks. In addition, since its users are less prone to utilize self-monitoring while in the redaction process, the sentiment attached to each individual word in a tweet is important and valuable for academic research since an increased amount of confidence can be set towards them. While the quality of the data retrieved from Twitter is indeed one of the reasons why academics tend to trend towards it, it should be noted that the API available to academic researchers allows for a vast amount of data to be extracted and analyzed - as opposed to other social media platforms such as Facebook who continuously restrict access via their API. For future reference, an application programming interface (API) is defined as an intermediary that allows two applications to talk to one another.

The tool utilized for the collection of tweets was a script using the programming language Python. This script was written by myself in a way that issued a request via the Twitter API every twenty-four (24) hours to gather the latest tweets that contained any of the keywords that were subject of this study. In this case, the programming script acted as one intermediary, and the Twitter platform acted as the second which was made possible by the API. These tweets were

then subsequently parsed through another Python script to match each individual word to a level of sentiment (compound score) as well as provide an overall score for the whole tweet. The numerical values that fell in each of the three sentiment categories (positive, neutral, negative) were the following:

Positive sentiment: compound score ≥ 0.05

Neutral sentiment: compound score > -0.05 and compound score < 0.05

Negative sentiment: compound score ≤ -0.05 (C.J. Hutto, Vader Sentiment, 2020, GitHub repository, <https://github.com/cjhutto/vaderSentiment>)

In order to identify whether second-layer blockchain solutions are ready for mainstream user adoption, the research strategy conducted for this study employed content analysis of tweets. Public tweets from January 2019 to December 2019 that included either the term 'Bitcoin', 'SegWit', 'YouTube', 'BitTube', 'Reddit', 'Steemit', and 'Lightning Network' were pulled and archived to conduct a sentiment analysis, a geographic analysis, and a network analysis. Analyzing the tweets that hold either of these keywords is important because we need to observe and evaluate the level of conversation happening between various groups of individuals. Analyzing individuals discussing centralized social media platforms such as YouTube and Reddit can be used to distinguish them from those who discuss their decentralized alternatives such as BitTube and Steemit. Identifying the quantity of attention each platform receives online, the geographic spread, and the online sentiment of each term helps the study determine the feasibility of mainstream adoption for decentralized alternatives.

The research strategy of using a collection of tweets is appropriate for the study because as of 2019, Twitter houses the largest share of Bitcoin community members compared to Facebook, Instagram, Tik Tok, and YouTube. This is further proved to be true due to many financial trading platforms using a populous Twitter sample to conduct a sentiment score which in turn informs traders whether or not individuals are speaking positively about the currency - or negatively. For instance, one of the largest cryptocurrency trading platforms called 'eToto' is now offering its clients access to Twitter sentiment analysis by feeding more than 850 million tweets through a machine learning algorithm. This bolsters Twitter's dominant and active role in the cryptocurrency community and supports why this study has selected the social media platform for content analysis.

In fact, no other online platform comes close to the amount of individuals actively posting and engaging with Bitcoin-related content on a daily basis. In a single day alone, the amount of tweets mentioning Bitcoin averages over 32,000. Comparatively, the second-largest online community for Bitcoin-related content is Reddit which only averages approximately 914 comments per day and 187 posts per day as of the time of writing⁴. Indeed, while Reddit is a large community for Bitcoin enthusiasts, its platform structure emphasizes less the minute-by-minute snippets of information that Twitter naturally promotes through the speed and simplicity of the drafting process. This leads to less general activity on the website in the form of overall posts and comments, but can arguably lead to an increase in the thoughtfulness of discussion due to the half-life of posts being higher. For example, due to the fast-paced nature of the Twitter platform, its half-life is the shortest of all social media platforms, about 18-20 minutes.

Comparatively, on the first page of the Bitcoin subreddit, posts from a day ago still appear for

⁴ <https://subredditstats.com/r/Bitcoin>

individuals to read and engage with. As mentioned, this increase in half-life could lead to higher levels of discussion, but lead to a diminished sample size for the content analysis of this study.

Lastly, since this study employed data collection archiving on a daily basis, Twitter was the natural fit in order to not only grasp tweets themselves, but to gather timestamp metadata on each of the tweets that can then be subsequently matched to pivotal moments in the Bitcoin community such as the release of the proposed Facebook cryptocurrency, Libra.

Additionally, according to a 2018 Omnibus Survey concerning awareness and usage of Bitcoin conducted by the Bank of Canada, male individuals aged between 18-34 with a university-level education were the most likely to be aware of the digital currency. Similarly, according to demographic details released by Twitter in regards to their users, 66% are male and 80% are described as affluent millennials. These demographic statistics reinforce why studying tweets posted on Twitter in relation to Bitcoin is the most effective and appropriate platform for understanding and evaluating the mainstream appeal to second-layer solutions.

An online content analysis was selected for this study in order to conduct unobtrusive research into the online behaviors of the Bitcoin community on Twitter and to transform a large amount of Twitter posts into a concise summary of key findings. This was crucial to analyze and understand how the two groups communicate and reference second-layer solutions without prompt or interference. Indeed, in order to test the hypotheses of Twitter message characteristics, it is important to observe users in their natural environment and to limit the possible inclusion of researcher bias and leading questions. In order for this study to truly capture whether or not second-layer blockchain solutions are ready for mainstream use - or are even included in the online conversation as a whole, the study needs to refrain from artificial discussion created by the researcher. Instead, careful analysis and examination of the naturally producing exchanges

over a long period of time is the most appropriate research strategy. On a similar note, since the coding unit of sentiment analysis discussed previously is not open to interpretation, a content analysis is a reliable way to analyze the Twitter qualitative data. As a result, this research strategy can be applied at a later date with a new set of Twitter data without compromising the research validity.

Sentiment analysis, or opinion mining, is a data science technique that revolves around building systems that are able to identify and extract opinions within the text. However, besides opinion identification, sentiment analysis can extract specific attributes of the expression such as polarity, and provide structured data from unstructured social information. The analysis can either be done at the document level, or at the sentence level. Document-level sentiment analysis looks at the overall body of text and provides a sentiment polarity score as a whole. Sentence level analysis, also known as aspect-based sentiment analysis (ABSA), categorizes a body of text into distinct groups and assigns a separate score for each. For instance, a single Reddit post about Bitcoin may fall under multiple different topics such as the speed of the network, transaction fees, infrastructure, and censorship. Aspect-based sentiment analysis would differentiate the different topics of conversation and assign a score to each of them. While the Reddit post could speak positively about the speed of the network, it could at the same time speak negatively about the fees associated with making a transaction. On the other end, document-level analysis reads the body of text as a whole and provides an overall sentiment score. In consideration of the fact that the study is conducting a content analysis from a Twitter stimulus, document-level sentiment analysis will provide the study with the most effective analytical tool because as of 2017, Twitter only allows 280 characters per tweet.

Additionally, given the fact that the restriction in characters of tweets promotes individuals to maintain a central and consistent topic in their redaction, the necessity of characterizing and evaluating each individual topic is unnecessary. Lastly, if individuals do require additional space for the composing of tweets to address multiple different topics, they do so by creating a Twitter thread that consists of multiple different individual tweets linked together. Since this study downloads and archives each unique tweet with the mentioned keywords, this does not pose a problem for the sentiment analysis research tool and further reinforces its appropriateness for the study.

Besides identifying at which level the sentiment analysis will be conducted, it is similarly important to distinguish in which way the study will implement the analysis. There are two principal ways in which sentiment analysis can be implemented: a rule-based system and an automatic based system. Firstly, a rule-based system performs sentiment analysis based on a set of manually crafted rules. These rules will identify information such as subjectivity and polarity by utilizing a lexicon which is a dictionary consisting of positive and negative opinion words as well as expressions. There are varying different kinds of lexicons that are publicly available and are helpful depending on the intended use.

The second method, an automated method, does not rely on a predefined set of rules, but instead on unsupervised machine learning techniques. While the specifically chosen algorithm will vary from researcher to researcher, they all follow a similar structure. In short, the algorithm is fed a set of text entries and returns a corresponding polarity score. Throughout the machine learning training process, the algorithm learns to associate a particular input with a particular output using various optimization strategies. This automated approach has a few considerable advantages, for one it has larger scalability compatibilities and more accurate results, but

requires a large enough training dataset. On the other hand, a rule-based approach requires no training data but is considered to be less accurate. The lower accuracy of a rule-based approach can be mitigated by using a social media-specific lexicon. In this case, employing the use of a Valence Aware Dictionary and Sentiment Reasoner (VADER) is appropriate because of its capability to handle a variety of Twitter-specific phonological sentence structures. For example, contractions as negations, conventional uses of punctuation, degree modifiers, sentiment-laden slang words, emoticons, utf-8 encoded emojis and has the ability to understand sentiment-laden initialisms and acronyms. While an automated approach could prove beneficial to unearth the meaning of words and sentences by utilizing a training model, VADER sentiment analysis is more appropriate to this study because of its specialized ability to attach a sentiment score to a string of social media text.

Indeed, the study and analysis of groups using sentiment analysis techniques have been shown to be especially effective for large datasets such as social media websites. Furthermore, VADER will allow the study to extract and analyze the varying degrees of emotional responses in regards to decentralized platforms while recognizing the importance of context in the vocabulary used on Twitter.

3.1 Procedures Adopted

The daily archiving of tweets containing the keywords ‘Bitcoin’, ‘SegWit’, ‘YouTube’, ‘BitTube’, ‘Reddit’, ‘Steemit’, and ‘Lightning Network’ were archived on a daily basis throughout a 12-month period by using the Twitter API in conjunction with the Python programming language. The Twitter API allows a developer to conduct complex automated

queries that would ordinarily be limited to manual extracting such as the gathering of a large number of tweets every day. This allowed the study to analyze a large longitudinal dataset of tweets that referenced pivotal moments throughout Bitcoin's development and industry development. For example, the introduction of Facebook's own digital currency, Libra, brought a substantially different caliber of conversation when compared to the predictable feature updates to the Bitcoin core network currently in development. In order to do so, a specific Twitter development application was created in order to authenticate the intended academic use of this study, and Python script was systematically programmed to run at 12:01 AM each day to collect and archive the social data for future analysis.

In order to use the Python programming language in conjunction with the Twitter API, the Tweepy library was used. In short, the library contains a collection of lines of code and functions intended for a specific use case. For this study, the Tweepy library provides us with the tools needed to collect and archive tweets.

After extracting and merging the tweets of each day, the tweets are stored in a JSON format (JavaScript Object Notation) in order to simplify its readability for the researcher and to allow the tweets to be easily machine parsable which will be important for the sentiment analysis stage of the research. Following the extraction of text, the tweets were then fed through the data cleaning tool OpenRefine in order to remove links and to remove tweets redacted in a language other than English. For the purpose of this study, only English tweets were analyzed and extracted because of the lexicon language limitations surrounding VADER sentiment analysis. In future studies, a larger collection of tweets covering more than one language would be beneficial in order to increase the dataset size and provide the study with an increase in validity. Figure 8

maps out a snippet of the python script used in this study to collect and archive data from Twitter.

Figure 8

Snippet of Python Script to Collect and Archive Twitter Data

```
from tweepy.streaming import StreamListener
from tweepy import OAuthHandler
from tweepy import Stream
access_token = "*****"
access_token_secret = "*****"
consumer_key = "*****"
consumer_secret = "*****"
class StdOutListener(StreamListener):
    def on_data(self, data):
        print data
        return True
    def on_error(self, status):
        print status
if __name__ == '__main__':
    l = StdOutListener()
    auth = OAuthHandler(consumer_key, consumer_secret)
    auth.set_access_token(access_token, access_token_secret)
    stream = Stream(auth, l)
    stream.filter(track=['Bitcoin', 'SegWit'])
```

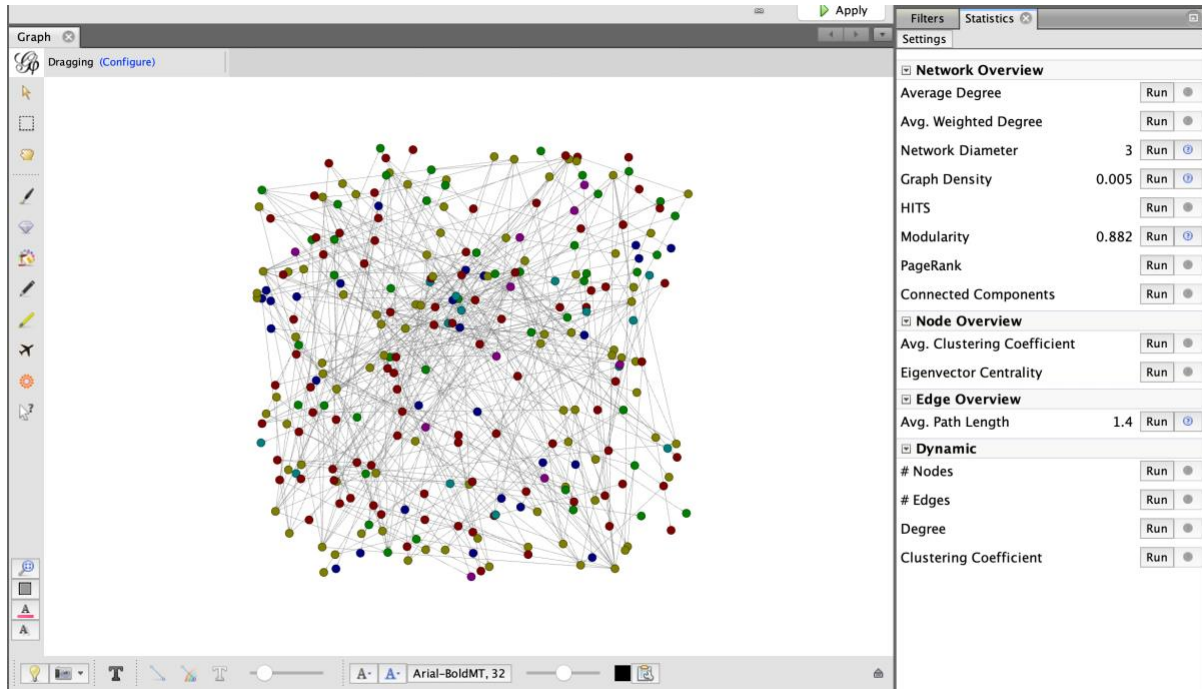
The text in the extracted tweets was imported to the VADER sentiment analysis tool because its lexicon is specifically tuned for social media posts including Twitter. According to documentation, the score is “computed by summing the valence scores of each word in the lexicon, adjusted according to the rules, and then normalized to be between -1 (most extreme negative) and +1 (most extreme positive)⁵. This is the most useful metric if you want a single unidimensional measure of sentiment for a given sentence. Calling it a 'normalized, weighted composite score' is accurate.” (Hutto & Gilbert, 2014).

⁵ <https://github.com/cjhutto/vaderSentiment>

Lastly, a network analysis was conducted with the data visualization software Gephi on the cleaned dataset in order to extract features such as the modularity, centrality, and diameter of the network. These scores, as will be explained further, helps the study identify which terms hold a broader community of individual users discussing it, and which terms seem to be discussed by a few individuals. Once the dataset of tweets for each keyword is imported into Gephi, the unique scores are calculated and exported for this study to analyze as can be seen in Figure 9.

Figure 9

Gephi Dataset and Measures



The decision to employ these analytical tools to analyze tweets is the most appropriate for this study because it minimizes the time needed to collect a large sample of data by automating the process on a daily and consistent basis. Additionally, in relation to VADER, it is emerging itself as an industry standard for analyzing social data since its rule-based lexicon is built with a specific social media lens.

In a 2016 study comparing most sentiment analysis methods amongst one another, Ribeiro, F.N., Araújo, M., Gonçalves, P. *et al.* (2016) noted:

The reasons for choosing VADER are twofold: (i) the fact that it is an open source tool, allowing easy replication of the procedures we performed in our study; and (ii) VADER's expressive results observed in previous experiments. [...] VADER's author identified five heuristics based on grammatical and syntactical cues to convey changes to sentiment intensity that go beyond the bag-of-words model. The heuristics include treatments for: (1) punctuation (e.g. number of '!'s); (2) capitalization (e.g. 'I HATE YOU' is more intense than 'i hate you'); (3) degree modifiers (e.g.

'The service here is extremely good' is more intense than 'The service here is good'); (4) constructive conjunction 'but' to shift the polarity; (5) tri-gram examination to identify negation (e.g. 'The food here isn't really all that great'). We choose VADER as a basis for such heuristics as it is one of the most recent methods among those we considered. Moreover, it is becoming widely used, being even implemented as part of the well-known NLTK python library.

By analyzing the data gathered from the *Ribeirido et al* 2016 study, Figure 10 showcases that VADER scores the highest level of accuracy for a Twitter dataset.

Figure 10

Experiment Results for Accuracy Surrounding Sentiment Analysis Tools Using Twitter Dataset

Dataset	Method	Accur.	Posit. sentiment			Negat. sentiment			Macro- F1	Coverage
			P	R	F1	P	R	F1		
<i>Tweets_RND_II</i>	AFINN	96.37	97.66	96.94	97.30	93.75	95.19	94.47	95.88	80.77
	ANEW_SUB	81.36	80.52	96.38	87.74	85.44	47.64	61.17	74.45	93.35
	Emolex	86.06	89.82	89.11	89.47	78.77	80.00	79.38	84.42	63.58
	Emoticons	97.75	97.90	99.42	98.65	96.97	89.72	93.20	95.93	14.82
	Emoticons DS	71.04	70.61	99.90	82.74	95.83	5.43	10.28	46.51	99.09
	NRC Hashtag	67.37	83.76	65.43	73.47	48.17	71.69	57.62	65.55	91.94
	LIWC07	66.47	74.46	78.81	76.58	44.20	38.31	41.04	58.81	73.93
	LIWC15	96.44	97.09	98.04	97.56	94.68	92.23	93.44	95.50	77.05
	Opinion Finder	78.32	93.86	71.11	80.92	63.42	91.50	74.92	77.92	41.23
	Opinion Lexicon	93.45	97.03	93.14	95.04	86.93	94.11	90.38	92.71	70.64
	PANAS-t	90.71	96.95	88.19	92.36	82.11	95.12	88.14	90.25	5.39
	Pattern.en	91.76	92.94	96.19	94.54	87.86	79.06	83.23	88.88	70.85
	SASA	70.06	82.81	72.81	77.49	49.05	63.39	55.30	66.40	63.04
	Semantria	91.61	96.94	90.55	93.64	82.25	93.88	87.68	90.66	63.61
	SenticNet	73.64	90.74	68.45	78.03	55.41	84.88	67.05	72.54	82.82
	Sentiment140	94.75	97.10	95.71	96.40	88.64	92.13	90.35	93.37	49.95
	Sentiment140_L	78.05	88.68	78.31	83.17	61.32	77.47	68.45	75.81	93.28
	SentiStrength	96.97	98.92	96.43	97.66	93.54	98.01	95.72	96.69	34.65
	SentiWordNet	78.57	87.88	80.91	84.25	61.09	72.87	66.46	75.36	61.49
	SO-CAL	87.76	94.25	86.99	90.47	77.34	89.32	82.90	86.68	67.18
	Stanford DM	60.46	94.48	44.87	60.84	44.06	94.30	60.06	60.45	88.89
	Umigon	88.63	97.73	85.92	91.45	73.64	95.17	83.03	87.24	70.83
	USent	84.46	89.28	87.67	88.47	74.77	77.63	76.17	82.32	38.94
	VADER	99.04	99.16	99.45	99.31	98.77	98.12	98.45	98.88	94.40

Chapter 4: Results and Analysis

In order to determine whether or not second-layer blockchain solutions are ready for the broader public, it is important to differentiate the two varying depths of public discourse and knowledge surrounding the topic of Bitcoin and blockchain itself. In the Twitter content analysis conducted, individuals had to be grouped and tagged as either having a strong or general grasp of the protocol before their tweets could be analyzed and studied. This allows the research to identify if discussions surrounding the second-layer have penetrated the mainstream, although still somewhat niche, general Bitcoin community, or if the topic is still solely discussed within technically knowledgeable individuals.

As was mentioned in the previous chapter, the term used to flag individuals who possess an enhanced knowledge of the protocol are ‘SegWit’, ‘Lightning Network’, and ‘BitTube’, while the term ‘Bitcoin’ was used to categorize those who engage in general and surface-level discussions. The Python script used to extract tweets includes additional metadata associated with individual tweets which allows the study to extract further data for analysis, such as location, language, reach statistics, date, time, and sentiment through the aforementioned VADER data science tool. For data validation purposes, the data set used in this study included retweets, non-English vocabulary text, and emojis UTF-8. However, in order to increase the validity of the sentiment analysis, only tweets drafted in English were analyzed using the VADER tool.

4.1 Tweet Quantity: SegWit

First and foremost, the overall quantity of tweets containing the term ‘Bitcoin’, ‘Lightning Network’, ‘SegWit’, ‘BitTube’, ‘Reddit’, ‘Steemit’ and ‘YouTube’ are analyzed in

order to identify the scope and size of each of the demographics studied – both technologically savvy users and the layman user.

This provides the study with a general understanding of the current social landscape for the Bitcoin sector and serves as an important starting point before conducting further, and more profound, social analysis. If this study has a goal of determining whether or not the second-layer is ready for mainstream adoption, it is crucial to compare and analyze the quantity of discussion for both groups. If the technical group who is most likely to understand and advocate for such a technology constitutes too minor of a share of the overall discussion, it can be argued that second-layer solutions will have a difficult time integrating into the overall Bitcoin narrative – and thus to a wider public. As was explained earlier, individuals who are conversing using highly technical terms are better positioned to not only understand second-layer technologies but adopt them.

While the quantity of tweets alone is not a determining factor when analyzing the likelihood for the adoption of new technologies – it does provide an indicator of social conversational trends. Since this study has captured twelve (12) months of Twitter data, it is thus possible to analyze month-over-month gains for all three terms and determine whether or not the community of technical users who have a theoretical grasp on the second-layer solution is gaining momentum – or if there is a decline in interest.

On that note, in a twelve (12) month period, from January to December 2019, the overall number of tweets that included any of the three terms amounted to 25,984,578. Of those individual tweets, those referencing the term ‘SegWit’ accounted for 0.17% of the overall share or 44,828 unique posts. It is important to note that online discussion surrounding SegWit hit a peak in April and May of 2019 (an approximate increase of 65% compared to regular

activity) due to two notable newsworthy events. Firstly, large, institutional cryptocurrency exchanges announced their support for segregated witness during these months which lead to an increase in social activity from individuals expressing their excitement for the adoption of this technological improvement to the Bitcoin protocol. For instance, on April 17th, an exchange owned by entrepreneurs Tyler and Cameron Winklevoss, named Gemini, announced their support for SegWit making it the largest cryptocurrency exchange to fully embrace this new type of Bitcoin address. Secondly, near the end of April, on-chain transactions on the Bitcoin network reached 452,462 transactions per day which was near the all-time peak for most transactions since Bitcoin's inception in 2009 (the network reached a high of 490,459 transactions in a day in 2017). In its past, an increase in transactions has led to a substantial increase in the amount charged in fees to send a transaction. Since segregated addresses were proposed as a way to mitigate this increase in fees in the event of a high volume of transactions, articles were written and shared in social networks that discussed the positive impact that SegWit has had on the Bitcoin network. In short, transactions were skyrocketing in April of 2019, but since many have opted to adopt SegWit, fees remained considerably lower than users were accustomed to in the past.

These two factors were not the sole justification for the peak of social activity during the months of April and May, however, they were large and newsworthy enough to constitute a significant portion of the online landscape on Twitter for the year. Overall, tweets referencing 'SegWit' averaged a net loss of -2.41% when percentages are calculated month-over-month and averaged out for the whole twelve months. This leads the study to propose that while newsworthy events have had positive short-term improvements to the quantity of discussion surrounding the topic of SegWit, and adoption of its use has risen considerably over time,

momentum has failed to build as individuals do not see fit to discuss it without reason to. To its credit, since SegWit was added to the Bitcoin protocol after much debate as was discussed in the previous chapter, it is now a technological improvement that works behind the scenes. This in turn means that individuals are now adopting and using the protocol upgrade without knowing and understanding it – let alone composing tweets mentioning it. With that being said, these individuals discussing SegWit on Twitter contain the same characteristics as the population of Bitcoin users who would understand second-layer solutions, and be more likely to adopt it. Nevertheless, as was identified in this study, the climbing rate of SegWit adoption amongst all users of the Bitcoin protocol may be a sign that there is increased sophistication in the discussion surrounding Bitcoin as well as a sign that newcomers entering the space are adopting it to fit in with the wider community as a whole - and to conform with the wider community consensus. Additionally, it is important to note that the economical benefits of adopting SegWit (namely a reduced fee structure to send transactions) made the adoption of the new technological improvement all the more likely. Indeed, newcomers learning about Bitcoin for the first time are likely to adopt SegWit due in part to its already established popularity in the space.

4.2 Tweet Quantity: Bitcoin

Unsurprisingly, in the same period of twelve months, tweets containing the word ‘Bitcoin’ totaled approximately 25,790,000 individual posts with a peak in July of 2019 corresponding to the following newsworthy events. The first, on July 11th, President of the United States Donald Trump tweeted his disapproval of both Bitcoin and Facebook’s proposed digital currency, the Libra, both of which are alternatives to American currency. These tweets invoked a strong reaction from the cryptocurrency community, namely because the President was publicly stating that Bitcoin was based “on thin air [and] unregulated crypto-assets can

facilitate unlawful behavior, including drug trade and other illegal activity” (Trump, 2019).

President Donald Trump has the 11th largest follower group account on Twitter. Regardless of which position individuals decided to take regarding the President’s sentiment, quantitative data shows that this tweet led to a peak in the number of conversations regarding Bitcoin. With an audience of that substantial size, the quantity of discussion engendered by Donald Trump’s attention to Bitcoin was certainly expected to rise significantly.

Additionally, in December of 2019, online public discourse surrounding a Bitcoin event, called the ‘Halving’ started gathering reach and engagements on Twitter which this study identifies as another newsworthy event that happened within the space. Put simply, the Bitcoin rewards per block is set as a decreasing function such that the sum of all rewards are to be finite. Currently, the issuance of Bitcoin on the blockchain every ten minutes is set at 12.5 Bitcoins and every four years, this amount gets cut in half (hence the term ‘halving’). The next scheduled halving event is set to take place in 2020, and as a result, the issuance of Bitcoin will be set at 6.5 in a short period of time. With only months to go until this event takes place, online conversations surrounding it surge as individuals flock to speculate about the ramifications of such a drastic economic policy. For instance, as December of 2019 marked the last month before 2020, speculation and news articles about the halving event scheduled for 2020 grew.

Specifically, on December 19th, 2019, the popular news account, Reuters tweeted to its 21 million followers that “[the Bitcoin halving is] set to shake crypto markets in 2020” (Reuters, 2019). This, as mentioned, led to an increase in the online discussion surrounding the event and led individuals to speculate in mass (namely about the potential price increase of a Bitcoin due to its cut in production).

Secondly, articles pertaining to Facebook's introduction of the Libra were widely written and shared in the month of July. Since many individuals see the similarities between the two currencies, for better or for worse, Bitcoin was mentioned alongside the Libra on Twitter. Discussions surrounding the regulatory constraints and the use case of Facebook's Libra was prominent – while the comparisons to Bitcoin were inevitable. Newly established digital currencies are more often than not compared to Bitcoin – and Facebook's step into the digital currency space contributed to the overall increase in mentions on Twitter. Lastly, in the month of July, Bitcoin went through notable price changes within a small period of time. For instance, in a single 24-hour period, the price fell approximately \$2,000 USD. While the currency is known for its unpredictable price changes over a medium to a long period of time, these extremely sudden changes do not happen regularly, and thus, constitute noteworthy events that are discussed and shared via Twitter.

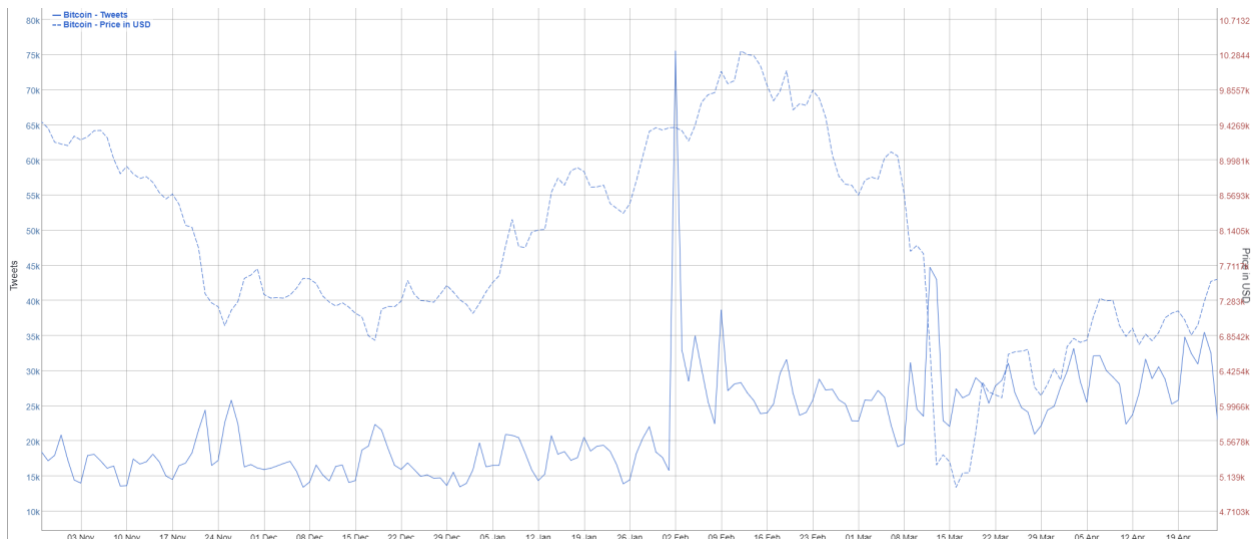
During its twelve-month period of time, the term 'Bitcoin' has had a significant decline in the overall volume of discussion – averaging a net loss of -30.44% month-to-month. Similarly to the SegWit trends, the social activity surrounding Bitcoin seemingly benefits on Twitter from short-term newsworthiness, as anything would, but the community of individuals discussing the topic fail to capitalize on the momentum to bring it to new heights. Indeed, without upgrades to the protocol or consistent mentions in the mainstream news, Twitter mentions of Bitcoin stagnate at a similar rate to SegWit mentions. Arguably, individuals solely discussing Bitcoin in relation to the Facebook Libra and extreme price swings are less likely to be equipped to grasp second-layer solutions, or aware of its implications for the decentralization of social platforms. This is why, for the purpose of this study, the fluctuations concerning the total volume of Bitcoin mentions are of less significance as the term is primarily used as a comparative basepoint for

other terms that would in fact be an indication of the likelihood of second-layer adoption. However, it is worthy of attention for future academic research and direction.

Another noteworthy mention in regards to the quantity of tweets referencing Bitcoin, for the months of October through December, the term experienced its lowest social activity on Twitter which correlated with a decline in the price per Bitcoin. As the price of Bitcoin decreases, the Twitter conversation has shifted from a focus on price to a focus on Bitcoin's technological advantages. In that way, conversations surrounding privacy, borderless payment gateways, and decentralized technologies increase in a period of price decline as the layman users who were simply looking to profit monetarily with Bitcoin are no longer involved as can be seen in Figure 11.

Figure 11

Price of Bitcoin (USD) and Volume of Tweets from November 2019 to April 2020



Alternatively, this study identified that the peak of social activity was in July and May - which is when the Bitcoin price achieved its highest monthly gain since October of 2018. On that

note, a large number of digital currency investors and research firms will use the spikes in Twitter activity as a signal to either purchase or sell the currency.

Arguably, the lower or higher quantity of tweets could be correlated to the diminished or surging price of the digital currency, however, statistical data can not determine this to be the sole justification for lowered social activity. As was mentioned previously, the price of the digital currency in conjunction with newsworthy events that appear in mainstream news are, when combined, the likely cause for lower social activity on Twitter.

4.3 Tweet Quantity: Established Decentralized Social Media Platforms

In addition to gathering the quantity of tweets regarding the terms ‘Bitcoin’ and ‘SegWit’, it is crucial for this study to identify the level and quantity of conversation surrounding already established decentralized social media platforms such as BitTube and Steemit. If this research is to determine whether or not these platforms are ready for mainstream adoption, it is important to not only analyze the quantity of tweets for the two selected groups containing varying degrees of knowledge but the already existing decentralized platforms themselves. In truth, if these platforms have already established a dominating presence internally in the blockchain space and externally in the wider public, this study argues that the platforms would have amassed a following large enough to be considered a successful adoption of new decentralized technologies.

In total, for a twelve-month period of time, tweets referencing the decentralized social video platform, BitTube, amounted to 8,856 tweets. This quantity corresponds to approximately 0.03% of the total social activity surrounding Bitcoin and blockchain on Twitter while trending downwards month-over-month. As a decentralized platform, BitTube has not reached a level of social activity that would deem it to be a contender in the blockchain space, nor has it

successfully reached individuals who use its centralized competitor, YouTube. Moreover, from the population of Twitter stimulus who are likely to understand the importance and technical aspects of second-layer solutions (those discussing directly the lightning network and SegWit), BitTube amounts to only 4.35% of that conversation. It may be argued that if the platform can only hold a small percentage of the conversation with individuals who are likely to adopt it, the likelihood of wide adoption remains low.

Steemit, on the other hand, presents a challenge for this study since it is not necessarily advertised as a decentralized platform, but a blockchain-enabled one. This means that while users are in fact using the blockchain to power the social network platform, they could be unaware of this fact. As a result, this study lists Steemit users as a mixed group containing both knowledgeable individuals who understand the second-layer, and layman users who are unaware that they are participating in a blockchain platform.

Knowing this, in the same twelve-month period of time, tweets discussing the Steemit platform totaled 176,460 reaching a peak of social activity in April of 2019 (23,100) and followed a similar downtrend to BitTube. This constitutes to Steemit holding a share of 0.67% of the total tweets in the Bitcoin and Blockchain space. However, as identified, this number cannot accurately predict the likelihood of mainstream adoption since its users contain a mixed variety of technical knowledge. Nevertheless, it does make the point that individuals are discussing Steemit at a much higher frequency compared to the other, more specialized platform, BitTube. It is thus a feasible assumption that the platform has perhaps benefited from its refrain towards highly technical language in its promotion and its insistence on the blockchain working behind the scenes.

While both BitTube and Steemit currently have a functional platform with similar technical characteristics, Steemit's social activity is 1892% higher and constitutes a larger share of the overall social conversation. While the total volume is not yet high enough to constitute a trend towards mainstream adoption, it is of interest to note the differences in social volume between the two. For reference, the two respective centralized platforms in which the two blockchain platforms are competing for market share with, Reddit and YouTube, have been analyzed.

4.4 Tweet Quantity: Established Centralized Social Media Platforms

From January to December of 2019, tweets mentioning YouTube alone totaled 78,860,000 - an amount that surpasses all blockchain and Bitcoin-related conversations put together. Comparatively, BitTube's social activity is only 0.011% of YouTube's. This helps put into perspective the scope of market share dominance that large corporations already have in their respective spaces. For instance, YouTube was created in 2005, well before any decentralized alternatives were even discussed, giving the platform a unique opportunity to be first to market and amass a loyal base of both content consumers and content creators. As we have seen throughout time, once a platform has established itself in a community, it is often difficult for a competing platform to have a substantial piece of that user base. Content consumers are naturally going to tend towards using the platform that has the most content creators – and vice versa. While a decentralized video platform free of censorship is a selling point for many in the Bitcoin community, it is demonstrably not a compelling enough argument for those in the broader mainstream public as can be seen with the quantity of social activity that both platforms have amassed in 2019.

Alternatively, the social activity on Twitter in relation to Reddit demonstrates a lower market dominance compared to YouTube. Indeed, this study argues that while YouTube currently dominates the video-sharing ecosystem on the internet, Reddit does not dominate the crowdsourcing of news and blogs. In total, social mentions of Reddit reached 3,146,000 individual tweets throughout 2019. When this is directly compared to its blockchain-enabled alternative, Steemit, an opportunity for an increased market share presents itself. Over the course of the year, Steemit's social activity was 5.6% of Reddit's. While this study would not deem Steemit to be ready for mainstream adoption based on this quantity of social activity alone, it does demonstrate the fact that already established social platforms have more of a likelihood to be replaced by decentralized alternatives if it does not have a substantial market share dominance.

However, while market share dominance is one determinant of whether or not a second-layer platform can succeed in the space, it is important to note that compelling incentives can also sway the public to lean towards one platform over the other. On that point, Reddit does not currently incentivize monetarily its users to post on the platform. Indeed, while users can buy each other a reward called 'Reddit Gold', this cannot be redeemed for dollars nor can it be exchanged for gifts or items. Since Steemit is a blockchain-enabled platform, they have created their own cryptocurrency that is rewarded to content creators based on the amount of individuals who view their post and can be redeemed for the monetary equivalent to their local currency. As a point of reference, at the time of writing, there exists over 5,200 individual cryptocurrency projects each utilizing their own specific blockchain and coin⁶. While the economies of digital tokens are outside the scope of this study, it is important to take this opportunity to discuss the

⁶ <https://coinmarketcap.com/>

proliferation of blockchain projects. This study introduces the distinct advantage of second-layer technologies for future decentralized social media platforms in conjunction with well-developed, secure, and most adopted digital currency, Bitcoin. If all public blockchain projects have a common goal of reaching mass adoption, the proliferation of unique coins only hinders each project, and the space as a whole. For instance, most of the cryptocurrencies offered to the public require their own unique digital wallet, and each have different methods of procurement (e.g. different exchange websites to buy and sell that are located in varying jurisdictions) which adds a tremendous and unnecessary learning curve for the layman user to traverse. To put into perspective, imagine you had a monetary currency specifically tied to a particular grocery store, another for a gas station, and another for a restaurant you visit frequently. Each one of these currencies would require separate wallets to store them, and different platforms to purchase them. Even in the digital environment, the segregation of these projects leads to a substantial decrease in user experience which in turn affects adoption rates amongst the mainstream public.

If the proliferation of cryptocurrencies is bad for general cryptocurrency uptake, why is there so much proliferation? Cryptocurrency projects develop new currencies not only to get over the technological limitations, such as the speed of the network, the ability to customize their coin to their desired specification, and the ability to fundraise by selling their newly minted coins to investors but to also maintain financial control of their network.

By creating their own currency on top of their own blockchain, each project can sell their newly created currency to individuals willing to speculate on the value and use case. Besides blockchain project creators enriching themselves by selling their own cryptocurrency, they are also oftentimes the ones who hold the majority of their own coins which in turn provides them with an immense amount of control over their blockchain. While Bitcoin has spent years

growing its network of users and further decentralizing itself, newer projects have a substantially smaller number of users which in turn results in a few majority stakeholders controlling the network and voting capabilities.

The failure to decentralize can have grave consequences for any blockchain-based system. For instance, in February of 2020, users of the Steemit platform reached a consensus and proposed a rule to disqualify the new owner of the platform to participate in future voting capabilities. This was a way in which the community attempted to decentralize itself further and limit the control that the largest stakeholder has on the network. While this proposal passed with community consensus (51% of total users), only three weeks later, this new governing rule was reversed by two entities who controlled a majority stake of all Steemit tokens. A hostile takeover of platforms, such as Steemit, is not a risk on the Bitcoin network due to its true decentralized structure.

The introduction of an incentivized system for posting on the platform was a new feature not available in the market at that time, which also played an important role in incentivizing Reddit users to post on their platform instead. These two reasons are why, the study argues, that in regard to the quantity of social activity on Twitter, Steemit's platform has a higher chance of mainstream adoption compared to BitTube.

Lastly, since the 'Lightning Network' is currently the most discussed second-layer solution to Bitcoin, this study analyzed the quantity of tweets that this term amassed from January to December of 2019 in order to identify its percentage of social dominance within the wider Bitcoin and blockchain space.

Similarly to SegWit, individuals discussing the 'Lightning Network' hold a generally above-average technical grasp on decentralized solutions and technology, and would be highly

likely to adopt them. However, this study argues that in order to achieve mainstream adoption, a second-layer solution related term needs to first and foremost establish itself with a strong presence in the general Bitcoin community before having a wider and more successful impact.

Having said that, for the same yearly period of 2019, tweets referencing the Lightning Network totaled 149,750 with a peak in March of 2019 (21,700) due to a few notable reasons. On one hand, a major US retailer, Kroger, announced they would no longer be accepting VISA credit cards for their stores due to the extremely high fees charged. This in turn led the Twitter Bitcoin community to suggest a truly decentralized payment system with little to no fees, the Lightning Network. As was mentioned throughout this study, opportunities for decentralized alternatives come when the market share dominance of already established platforms lowers. In this case, Kroger announcing the lowering of VISA's market share presented an opportunity for the Lightning Network to fill that gap and naturally led to a peak in social activity.

Lastly, on March 17th, the Lightning Network hit a record capacity of 1,000 BTC (the approximate equivalent to \$9,479,153 CAD). For a technology still in its infancy, this transactional capacity was an impressive demonstration of the network's success and ability to remain operational under heavy strain.

When we compare the tweets discussing the Lightning Network to the broader Bitcoin community, the term holds approximately 0.58% social dominance which is demonstrably higher than that of SegWit but constitutes a significantly smaller share of the social activity surrounding Bitcoin and blockchain.

To sum up, from the quantity of tweets analyzed, we can combine the terms that technologically knowledgeable individuals are discussing (which is those of who are likely

higher to adopt decentralized second-layer platforms) to have a total representative share to compare to the wider Bitcoin social activity.

This study identified that those discussing SegWit, Lightning Network, and BitTube are highly knowledgeable about second-layer solutions and are more likely to adopt it while those discussing Steemit are of mixed variety containing both the layman user and the ones with great knowledge. With that in mind, the quantitative total representative share of individuals who understand the second-layer is 203,434 while mixed users remain at 176,460. This corresponds to individuals highly likely to adopt second-layer solutions at 0.79% of the overall Bitcoin community and mixed at 0.67%. Interestingly enough, out of all Bitcoin and blockchain-related terms, Lightning Network is the only one experiencing an uptrend in the quantity of social activity and YouTube is the only centralized platform on a similar uptrend. This points to the importance of future studies to re-examine the topic at a later date.

4.5 Geography of Tweets

This study has proposed that the quantity of social activity on Twitter is a determining factor to identify whether or not a platform or technology is ready for mass adoption. Building from that, the geographic region of where tweets are originating from can also be used to recognize the centrality of where its users are located as well as to further explore the demographic characteristics of both tech-savvy and novice users of blockchain technology. A high spread of users spanning multiple countries, political boundaries, and cultures would indicate a favorable likelihood of mainstream user adoption. In this respect, geographic metadata associated with tweets about each platform was analyzed and comparatively studied. The study started with the two centralized social platforms YouTube and Reddit in order to identify a baseline for the decentralized platforms to be compared to.

4.5.1 YouTube

To begin, individuals discussing YouTube on Twitter are roughly 26% from the United States, 26% from Japan, 4% from Brazil, 3% from Thailand, 3% from the United Kingdom, and 3% from Mexico. In addition to these regions, there are 171 other countries that fall within or under 2% of the overall sample. This means that in total, there were 176 different countries discussing the platform from January to December of 2019. Figure 12 maps out the geographical spread of individuals discussing Youtube.

Figure 12

Geographic Spread of Tweets Mentioning YouTube



4.5.2 BitTube

Alternatively, its decentralized alternative, BitTube, had 29% of its Twitter traffic coming from the United States, 8% from the United Kingdom, 5% from Russia, 5% from Canada, 4%

from Germany, 3% from France, and 3% from India. In total, BitTube social activity spanned 135 different countries which corresponds to approximately a decline of -23% when compared to its centralized counterpart.

Twitter conversations about blockchain-backed social media reflect local concerns. For example, conversations surrounding BitTube in the United Kingdom were focused on the ongoing Brexit movement and worries about increased political censorship. Since individuals living in the United Kingdom were subject to political disinformation campaigns and media biases were prevalent and ongoing, it can be argued that users flocked to a decentralized and censorship-resistant platform in order to digest their information. For instance, many users posted tweets about YouTube videos discussing Brexit being removed and censored to the wider public. As a result, mentions of BitTube grew as users decided to upload their content on that platform instead. Figure 13 maps out the geographical spread of individuals discussing BitTube.

Figure 13

Geographic Spread of Tweets Mentioning BitTube



Furthermore, increased traffic in Germany can be attributed to individuals discussing the technology behind the platform itself. While other geographic regions focus on the sociological implications of a decentralized platform, many individuals residing in Germany focused on the complex file-storing method that a decentralized network needs to build in order to host large video files. For example, in November of 2019, a large cluster of users engaged in a discussion surrounding the InterPlanetary File System (IPFS) which is a peer-to-peer network protocol that can host large files for others to download. This file system was built into the BitTube platform during its inception. Additionally, BitTube released in that period of time a new feature in their platform that allowed individuals to utilize a VPN (Virtual Private Network) service in order to mask online internet activity. This specific feature was commonly discussed with individuals residing in Germany who often touted the feature as a commonly “undervalued” privacy tool. A reason for Germany’s particular interest in internet privacy and technology could be rooted in their historical past. For instance, individual privacy in the era of the Gestapo was almost non-existent as surveillance of the public continually increased to identify enemies of the state. While these surveillance techniques by the government have since ceased, public paranoia has shifted

toward large corporations such as Google and Facebook. Indeed, Germans are even reluctant to trust banking institutions: Germans rely on cash transactions more than similar-sized economies. In a country in which governments and banks collapsed and reformed over and over in the last century, stocks collapsed and war bonds went unpaid, such suspicion is understandable. In this case then, it would be natural that the German public is increasingly interested in decentralized platforms that can offer an increase in online privacy. A recent study suggested that “East Germans, who have lived under the communist system, have a persistently lower willingness to take stock-market risk, even almost 30 years after reunification” (Laudenback et al., 2020).

The higher geographical spread of YouTube’s social activity on Twitter indicates to this study an already established foothold in the video content creation and consumption space, and thus, makes BitTube’s entry in the market all the more difficult. If however, in the future, BitTube expands its community of users, this trend could be identified with the analysis of geographic volume and the argument could be made for the decentralized alternative’s mainstream use case and adoption.

As an aside, YouTube is the most popular video-sharing platform in Japan and has reached over 62 million monthly active users as of October 2018 (Statista Research Department, 2019). Since Japan is also considered to be among one of the most cryptocurrency-friendly countries in the world, it is interesting for this study to note its lack of adoption for BitTube. Perhaps, as opposed to Germany, it is the lack of Japan’s demonstrable historical need for censorship resistance and online privacy that corresponds to its lowered adoption rate. Indeed, if a country known for its favorable adoption of blockchain-enabled platforms and projects corresponds to only roughly 2% of the online conversation, an argument could be made that the platform has not reached a wide consensus to its intrinsic need and desire. However, perhaps an

even more important indication of adoption would be to analyze regions in the world that have highly restricted access to the internet in order to identify if they have adopted a decentralized alternative. Since a borderless and censorship-resistant content platform is the mission statement for many decentralized projects, including BitTube, this is a crucial topic for this study to explore.

In that way, as was explored in a previous chapter of this thesis, the Great Firewall of China poses an interesting argument for the need of decentralized platforms. Since 2009, YouTube has not been accessible in China due to the government's ban on the platform. In a time where individuals should be migrating to platforms that increase their sense of creative liberty and freedoms, social mentions of BitTube in China only total 2% of the overall geographic demographic. However, this is not a logical argument to be made since Twitter is also a platform blocked by the Great Firewall of China. This means that the sample of social activity does not accurately capture the Chinese demographic – and in turn an assumption cannot be made that users in China have not already migrated to decentralized platforms instead of YouTube. This is an important metric in evaluating decentralized alternatives that future studies can build on if platforms such as BitTube ever release their demographic data.

4.5.3 Reddit

With YouTube and BitTube analyzed, the study moves to the two social blog platforms, Reddit and Steemit. Starting with Reddit, social activity on Twitter referencing it consists of 34% of individuals originating from the United States, 6% from the United Kingdom, 4% from Mexico, 4% from Canada, 4% from Germany, and finally, 4% from South Africa. The reason why Americans trend so heavily towards the platform compared to other demographics is above the scope of this study, however, the study argues that since Reddit was originally created in the

United States, it was able to attract mostly American citizens which in turn leads to more US-focused content creators and consumers. Figure 14 maps out the geographical spread of tweets mentioning Reddit.

Figure 14

Geographic Spread of Tweets Mentioning Reddit



In total, Reddit's social activity on Twitter spanned 200 countries. This geographic spread is roughly 13.6% higher than that of YouTube and 48% higher than BitTube.

4.5.4 Steemit

Comparatively, for the decentralized alternative Steemit, 35% of tweets mentioning the platform were from the United States, 17% from South Africa, 7% from the United Kingdom, 5% from Nigeria, 3% from Canada, and 3% from India. In total, Steemit was discussed across 130 different countries in the same time period of January through December of 2019. An interesting note, Steemit is the only platform to have a significant reach from individuals living in South Africa and Nigeria. As developing countries, an argument could be made that these

individuals see the economic benefit of publishing on the Steemit platforms in order to be monetarily rewarded with a blockchain-enabled token that can be exchanged for their local currency. The fact that anybody on the Steemit platform can be rewarded for writing or sharing content that others consume could be consistent with its increased market dominance in emerging and developing countries. This points to the strong desire for a decentralized platform that rewards its users solely based on their throughput of work consumed by others – and is possibly why Steemit is able to reach significantly important geographic locations that new decentralized and blockchain-enabled platforms can thrive with. While Reddit still had the most countries discussing the platform, Steemit's more significant growth in developing countries demonstrates a market desire for such a platform – and the economical advantage that blockchain-enabled networks can create. To summarize, while the geographic spread of Steemit does not necessarily characterize a readiness for mainstream adoption, it does point to its purpose for existing as a platform, and as a result, should benefit from continued development and improvements. Figure 15 maps out the geographical spread of tweets mentioning the decentralized platform Steemit.

Figure 15

Geographic Spread of Tweets Mentioning Steemit

Steemit



Map based on Longitude (generated) and Latitude (generated). Color shows sum of Number of Tweets. Details are shown for Country.

Finally, the three terms Lightning Network, SegWit, and Bitcoin were analyzed for their geographic impact in order to identify where the knowledgeable users are located, and where the layman Bitcoin users are. This helps the study identify if the scaling solutions are ready for mainstream adoption because a larger spread of countries can constitute a bigger adoption rate. However, as was mentioned previously, this is not the sole factor corresponding to the likelihood of readiness for the masses but serves to this study as an indicator.

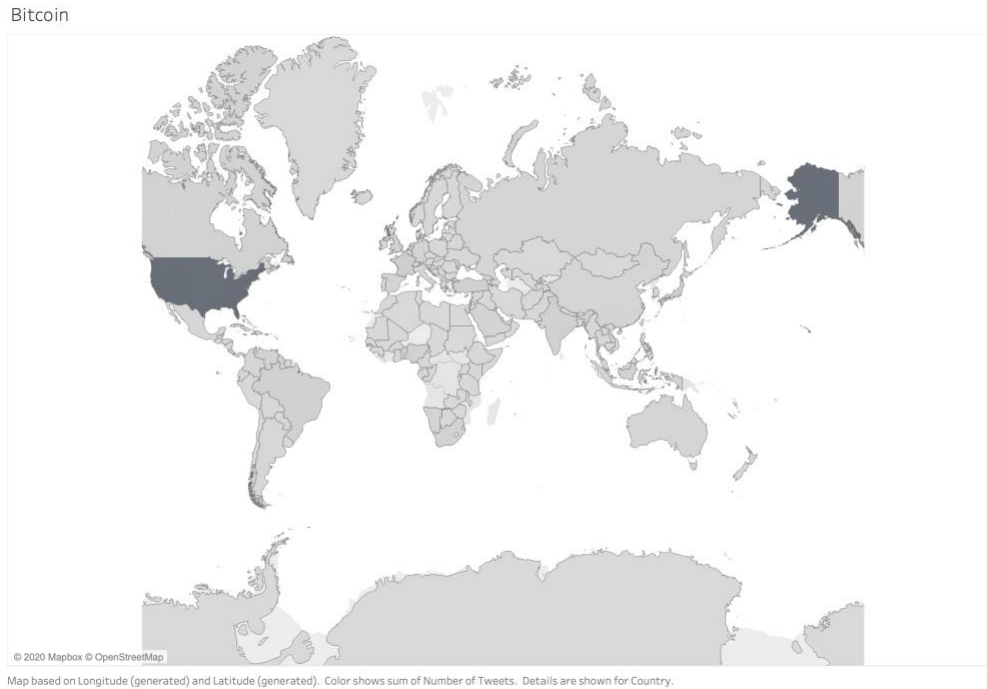
4.5.5 Bitcoin

To begin, Bitcoin had the most number of countries discussing it on Twitter totaling 213 countries. This is interestingly the highest of all the centralized and decentralized platforms studied, and can perhaps be explained by Bitcoin's truly global and borderless impact. Bitcoin is

not owned by any institute or company, it lives on the internet. This is perhaps why the digital currency was able to amass such a diverse crowd of users, or at the very least, individuals who are interested. From that sample size, 32% are from the United States, 7% from the United Kingdom, 3% from Turkey, 3% from Japan, 3% from India, 3% from Nigeria, 3% from Brazil, and 3% from France. What this shows is that while Bitcoin remains the most widely dispersed topic geographically on Twitter, its representation is still overwhelmingly based in the United States. A reason for this could be that in 2019, news revolving Bitcoin mainly originated from the United States as can be demonstrated by the earlier mentioned President Donald Trump tweet. Figure 16 maps out the geographical spread of tweets mentioning the decentralized peer-to-peer currency, Bitcoin.

Figure 16

Geographic Spread of Tweets Mentioning Bitcoin



4.5.6 SegWit

On the other hand, SegWit related topics on Twitter originated from 173 countries in total. Once again, the United States had the largest share of the conversation at 30%, Japan at 12%, the United Kingdom at 7%, the Netherlands at 5%, Australia at 4%, and finally, Canada at 3%. Once again, the indication of Japan being increasingly cryptocurrency and blockchain forward-thinking is further illustrated by the fact that Japan consists of the second biggest country for individuals who possess a strong technical grasp of Bitcoin and blockchain – those that this study identified as those who use the term SegWit. Once again, the argument could be made that both Steemit and BitTube’s failure to hold a market share in Japan could be indicative that the decentralized platforms have further room for growth and improvement before being considered to be ready for mainstream adoption. Figure 17 maps out the geographic spread of the technological improvement protocol change, SegWit.

Figure 17

Geographic Spread of Tweets Mentioning SegWit



4.5.7 Lightning Network

Lastly, the term Lightning Network reached a total of 158 different countries around the world but provided the study with the most interesting geological spread. Once again, the United States held the biggest share compared to other countries, however, since the technology was created in San Francisco, it is only logical the growth stemming from the United States would be the highest. With that being said, out of all terms analyzed in this study, the United States comprised the smallest share of the overall countries, holding only 23%. Secondly, the Philippines held 11%, the United Kingdom 6%, Venezuela held 4%, Netherlands 3%, India 3%, Indonesia 3%, and finally France 3%. Interestingly, Venezuela, a country that is currently undergoing a currency crisis has a decisive interest in the Lightning Network. Figure 18 maps

out the geographic spread of tweets mentioning the second-layer technology, the Lightning Network.

Figure 18

Geographic Spread of Tweets Mentioning Lightning Network



A reason for this can be found in the primary reason for the Lightning Network to exist – a way to transact any fractional amount of Bitcoin using peer-to-peer technology and the second-layer. In a country where its currency has seen excessive inflation and devaluation, perhaps individuals living in Venezuela are looking for an alternative currency they can use to transact among one another that is not subject to the same fate as the currently utilized fiat currency. While Venezuela’s interest in the second-layer does not necessarily mean the country is most likely to adopt decentralized alternatives, it does indicate an interest in disruptive technology that future research should focus on. The United Kingdom, while not as politically and economically

unstable as Venezuela, is still facing a period of political and financial uncertainty stemming from the Brexit campaign. If this study is to propose that financially and politically unstable countries are more likely to flock towards decentralized blockchain platforms, the ramifications of the outcome in regards to Brexit would be an interesting area for future research. While the United Kingdom has officially left the European Union as of January 31 of 2020, the shifts in online behaviors such as the possible trend towards censorship resistance and individual privacy take time to materialize and as a result, research needs to be conducted at a later date once the dust settles. To summarize, this study worked on the methodological assumption that a high spread of users spanning multiple countries, political boundaries, and cultures would indicate a favorable likelihood of mainstream user adoption. With that in mind, the two centralized platforms, YouTube and Reddit, had the highest total number of geographic regions discussing the platform. This is of no surprise for the study because both platforms are indeed already established and widely adopted throughout the world – with China being the notable exception due to the aforementioned firewall. Following this, those discussing SegWit were dispersed the most geographically out of all the other decentralized terms, indicating its higher likelihood of mass adoption. Once again, however, while SegWit was indeed a highly contested technological update to the Bitcoin core code and protocol, it has since reached a consensus by the community and has been adopted. This helps support the study's notion that a higher geographical reach leads to an increased likelihood of adoption. Out of the remaining three terms, the Lightning Network holds the largest geographic span of social activity which would point towards its increased likelihood of wide adoption. This, in addition to the Lightning Network being the sole term experiencing an uptrend in quantifiable social conversation, as was discussed previously, leads the study to continue the conversation that perhaps individuals are more so interested in the

second-layer, rather than cumbersome decentralized alternatives. On that note, Steemit and BitTube have the hard task of competing for market share from the larger and dominating platforms Reddit and YouTube. Meanwhile, the Lightning Network is able to grow and establish itself in a space with little to no competition which only increases its likelihood of success. Again, a technology that has already fully occupied a space is incredibly difficult to unseat even if a better alternative comes forward. A further result provided by the geographical analysis is that the likelihood of adoption is more often than not based on necessity. In a modern technological space where we already have centralized platforms, decentralized alternatives will have a harder time being adopted. As was explored with the currency crisis in Venezuela, the necessity of a payment system that is founded on hard money led the term Lightning Network to see month-over-month growth and an increased adoption rate. Similarly, since individuals living in Venezuela are not subject to any internet-based restrictions and censorship, the need for a decentralized alternative to YouTube and Reddit is not prevalent.

Lastly, a further demonstration of adoption being rooted in necessity was illustrated in South Africa and Nigeria's adoption of the economical benefit of Steemit. For individuals wanting a platform that provides them direct financial gain in an emerging economy, Steemit was able to capture their attention – and in return their adoption. Future research should conduct a qualitative study to identify further indications to adoption based on geographic region.

4.6 Network Analysis

Before conducting a sentiment analysis for the tweets extracted, it is crucial for this research to conduct a social network analysis in order to identify the degree of complexity and interconnectedness for each of the terms. By doing so, this study can quantitatively evaluate whether terms are discussed within a small community of individuals, or if the terms are

discussed amongst a broader and diverse group of people. Similarly to the geographic analysis, this can help identify the scope of the conversation surrounding the seven terms, and in turn, help the study to identify whether or not some of these technologies are ready for mainstream adoption.

The first metric used in this analysis is the network diameter. In short, the higher the diameter of the network, the bigger the network's overall size. In addition to the diameter, the study will analyze the degree of centralization. These metrics correspond to whether or not a few central participants are the ones dominating the flow of the conversation. The closer the centralization value is to 1, the greater the participation of a few individuals. Lastly, modularity is a term used in social network analysis to determine whether clusters found in the network represent distinct and separate communities. The higher modularity value, the more likely communities are determined to be divided, and values lower than 0.5 often indicate the social network to consist of a fewer number of nodes.

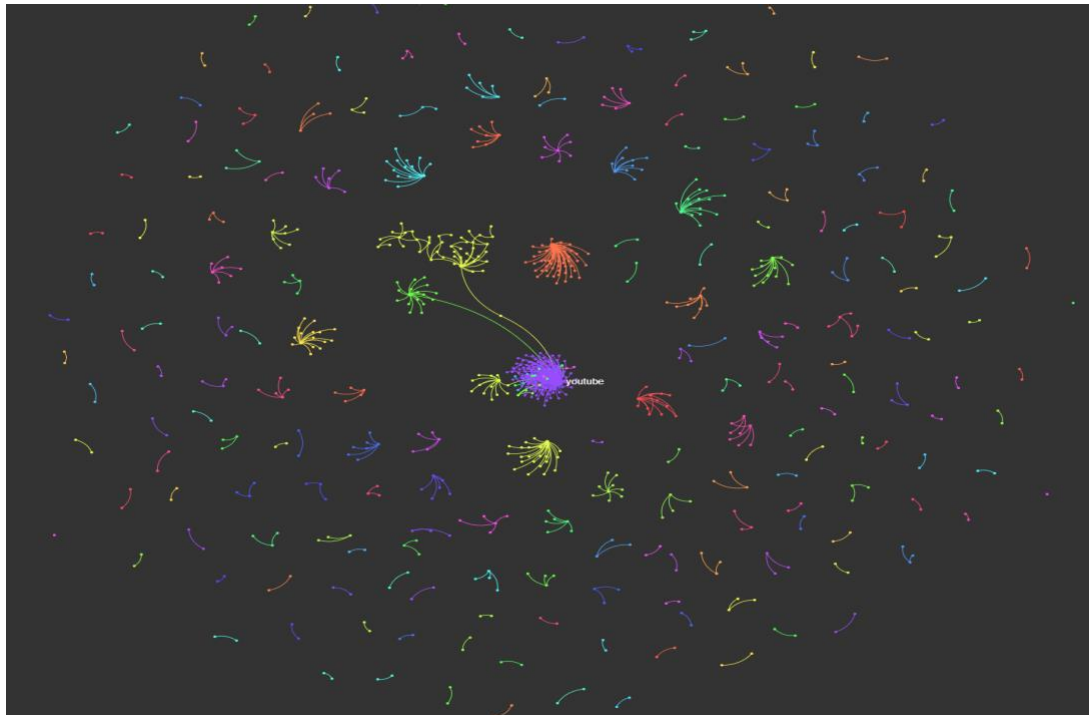
4.6.1 YouTube

YouTube, as a BitTube comparator, was the first term being analyzed from network analysis. The diameter of the entire Twitter network from January to December of 2019 had a value of 2, the degree of centralization had a value of 0.1413, and finally, the network had a modularity value of 0.844. The first point of interest is YouTube's very low degree of centralization in the network. As can be visualized, this means that the conversations on Twitter including the term YouTube consist of many unique individuals - instead of a few key central players. This, along with the previous results, further helps illustrate the platforms already established mainstream adoption. On a similar note, since the term scored a high modularity value, it illustrates the fact that the community on Twitter discussing YouTube is incredibly

divided. For example, YouTube content creators fall under a distinct set of categories such as gaming, education, comedy, and news. This subset of groups, while all uploading their content on the same platform, draw different kinds of audiences from around the world. As a result, the modularity value of YouTube-related tweets is higher. These audience characteristics for tweets surrounding Youtube can be visualized in Figure 19.

Figure 19

Network Analysis of YouTube

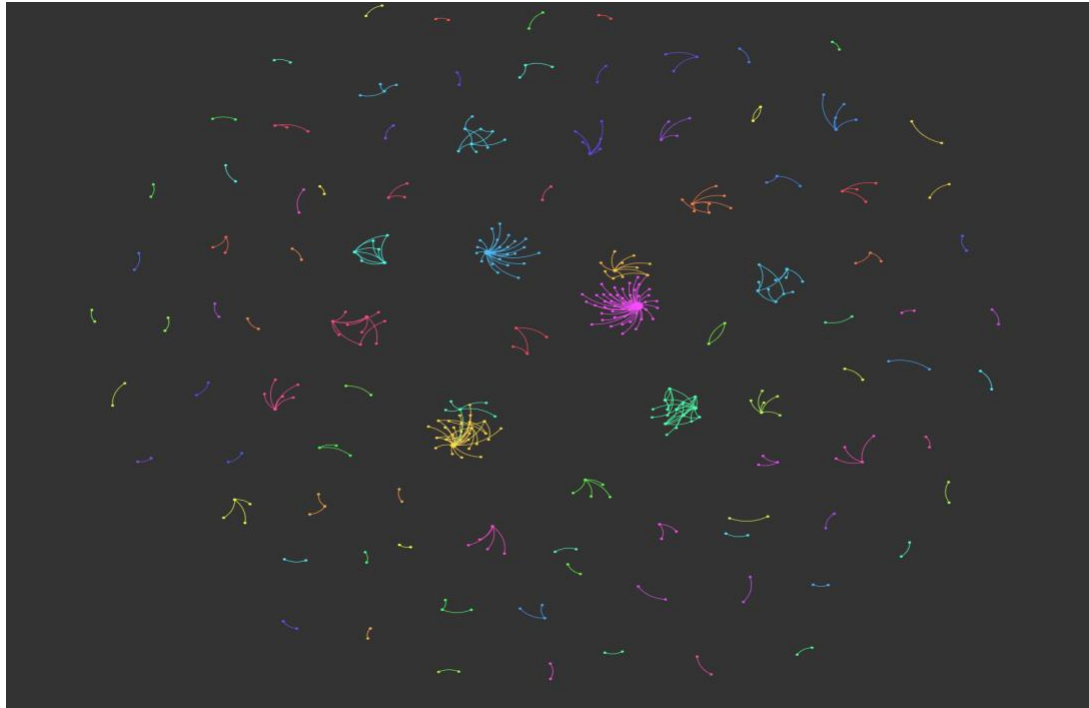


4.6.2 Reddit

Secondly, Reddit's total network diameter has a value of 1, its degree of centralization is 0.032, and its modularity value is 0.97. Much like YouTube has distinct communities within the platform, Reddit is shown to be even more divided. These results are not surprising since Reddit was created for individuals to build their own communities within the platform, called subreddits. For a platform built from its inception to accommodate even the most fringe of communities, its modularity score is bound to be higher in comparison to other platforms. To further illustrate this, as of December 27th of 2019, Reddit has 1,813,905 individual subreddits ranging from a multitude of different demographics and categories. While this study does not measure the social network graph of Reddit as a platform itself, its value of modularity and separateness carries over to individuals referencing the platform on Twitter as can be seen in Figure 20.

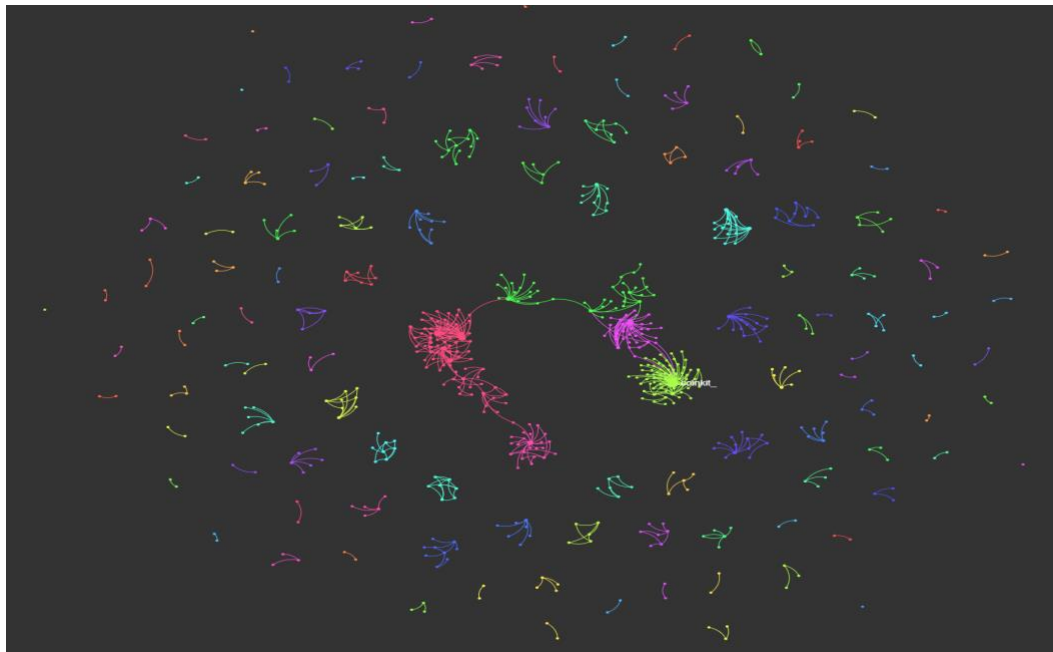
Figure 20

Network Analysis of Reddit



4.6.3 Bitcoin

Thirdly, Bitcoin's social network diameter has a value of 24, a centralization value of 0.073, and a modularity value of 0.73. This means that Bitcoin's overall network size was larger than YouTube's, and was highly decentralized in its conversations on Twitter. In essence, this draws a similar conclusion to the geographical analysis whereas the conversation surrounding Bitcoin consists of various different networks of individuals each in their own distinct communities. However, as an important note, Bitcoin's modularity value is lower than Reddit and YouTube's which means that the community of individuals discussing Bitcoin on Twitter is considered to be less divided compared to the two centralized platforms. These results remain consistent with the studies' assumption that platforms that are built to segregate its users in different categories will more often than not be divided compared to that of a term referring to a global digital currency. The aspect of decentralized conversation surrounding the term Bitcoin is illustrated in Figure 21.

Figure 21**Network Analysis of Bitcoin**

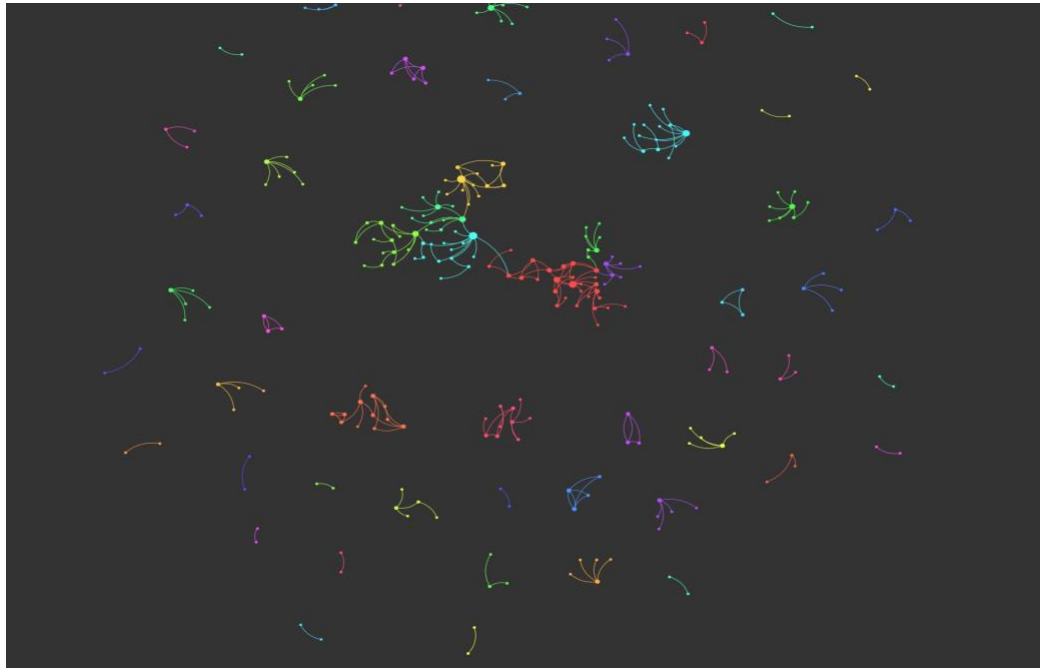
4.6.4 SegWit

Fourth, the term SegWit has a network diameter of 2, a centralization value of 0.019, and a modularity value of 0.90. This leads the study to stipulate that when compared to Bitcoin, SegWit's conversation on Twitter spans more unique communities and the discussion is centralized less to a few individuals. As an already adopted protocol upgrade to the Bitcoin code in August of 2017, the nature of its decentralized conversational habits is not a surprise to this study. However, this study argues that during the times of the highly contested debate that happened in the Bitcoin community as to whether or not to adopt this change in the code, the conversation on Twitter would be highly centralized towards a few key individuals who were acting as opinion leaders. Because extremely divisive groups were formed by a few prominent members, this would have resulted in far different results for the modularity and centralization of

the network as can be seen in Figure 22. Since this research only captured conversations from January to December of 2019, a future study could conduct a longitudinal comparison as to the centrality of the network pre-implementation and post-implementation.

Figure 22

Network Analysis of SegWit



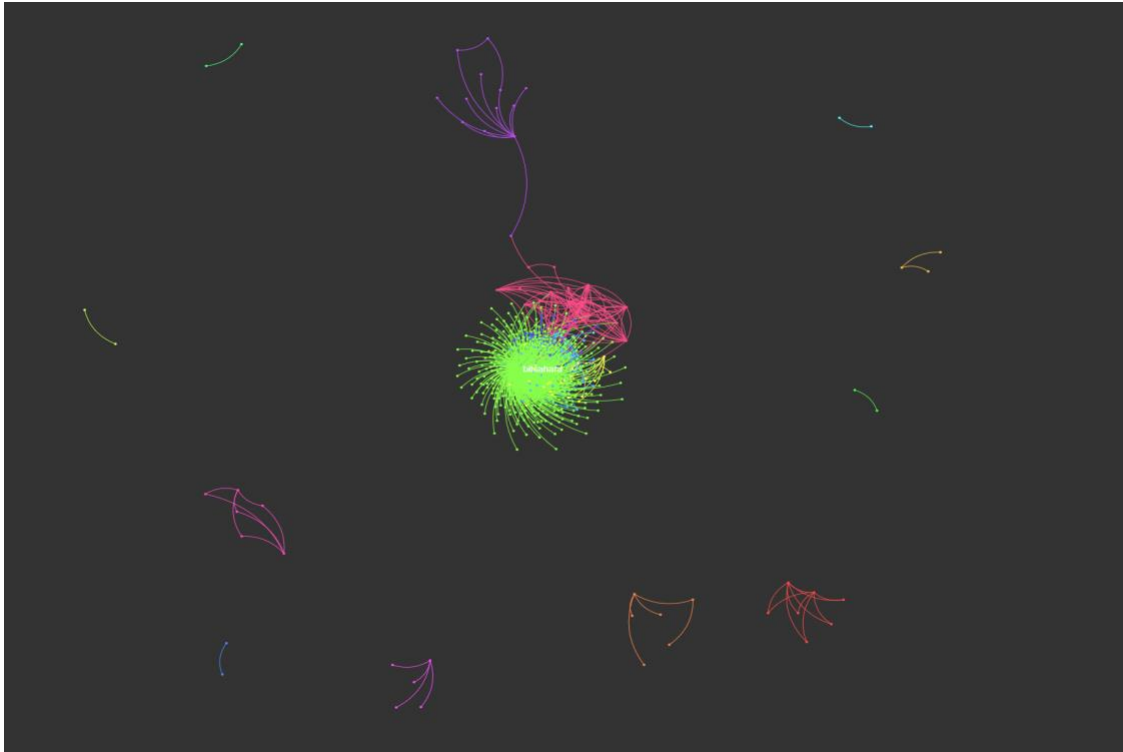
4.6.5 Lightning Network

Fifth, the Lightning Network contained a network diameter of 2, a centrality value of 0.39, and a modularity value of 0.48. These results are interesting to note because it means that the Lightning Network conversation on Twitter consists of a main core group of nodes or opinion leaders. Since the technology was created by a singular working group in the United States, the flow of the conversation surrounding it is likely to trend towards the people building it and releasing information about it. Once the technology is fully developed and out of its experimental stage, this study argues that the centralized nature of the conversation will weaken

and broaden to the general public because individuals will no longer be turning to a single entity for the propagation of news. Figure 23 visually illustrates the high degree of centralization on Twitter about the Lightning Network.

Figure 23

Network Analysis of the Lightning Network



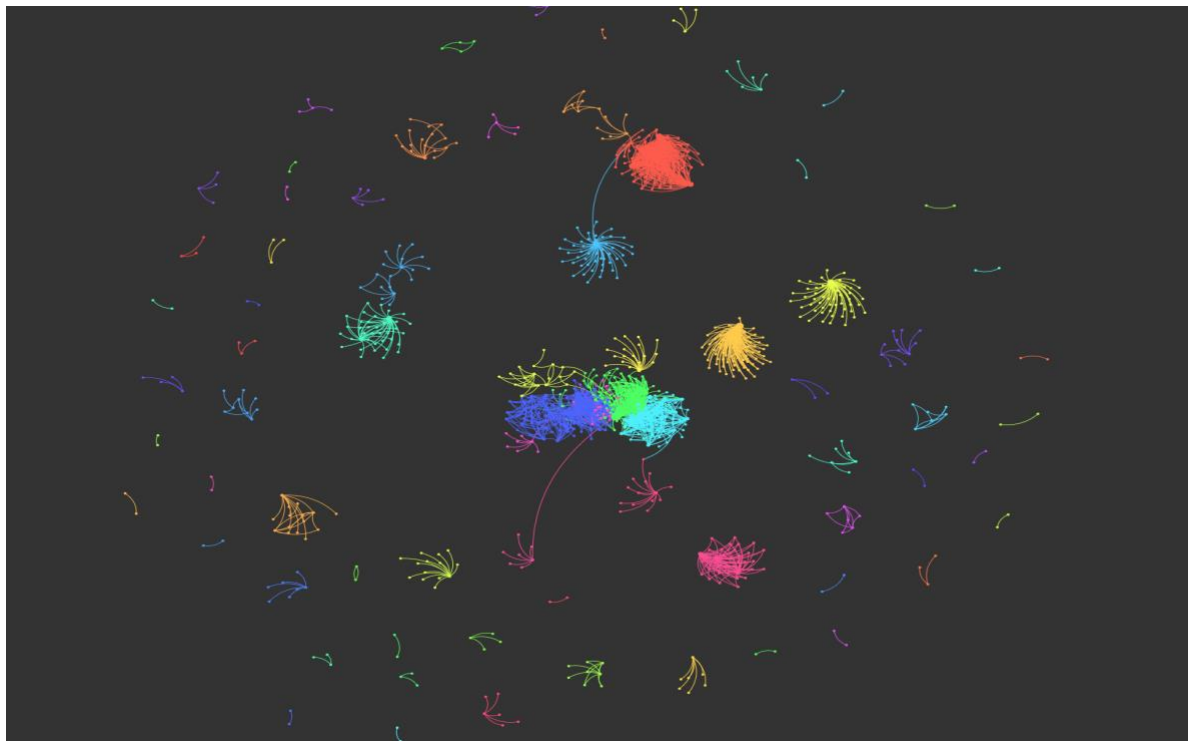
4.6.6 Steemit

Sixth, conversations surrounding the Steemit platform had a network diameter of 1, a centrality value 0.076, and a modularity value of 0.79. When compared to its centralized counterpart, Reddit, the decentralized alternative witnesses an approximately 58% reduction in its decentralization of conversation. Additionally, Steemit's modularity value is approximately 18% lower than that of Reddit's which indicates to this study that the conversation on Twitter is slightly more consisted of a few core group of nodes. A notable reason for this could be the previously analyzed geographical span of individuals discussing each of the platforms. Because Reddit's spread of countries was higher than Steemit's, the degree of division between the network would, therefore, be higher due to these communities being unlikely interwoven among one another. This further reinforces the argument being made in this study that decentralized blockchain-enabled platforms have a difficult time entering a space already dominated by a

centralized counterpart. Indeed, in order for this study to indicate Steemit's readiness for mainstream adoption, the platform would need to compete more aggressively with Reddit's centralization and modularity values. This study suggests that true mainstream adoption comes by way of large and diverse communities coming together onto one platform. While Steemit has seen growth in developing communities, the results provided by the network graph in Figure 24 demonstrate the need for further improvements before being considered to be a contender to Reddit.

Figure 24

Network Analysis of Steemit



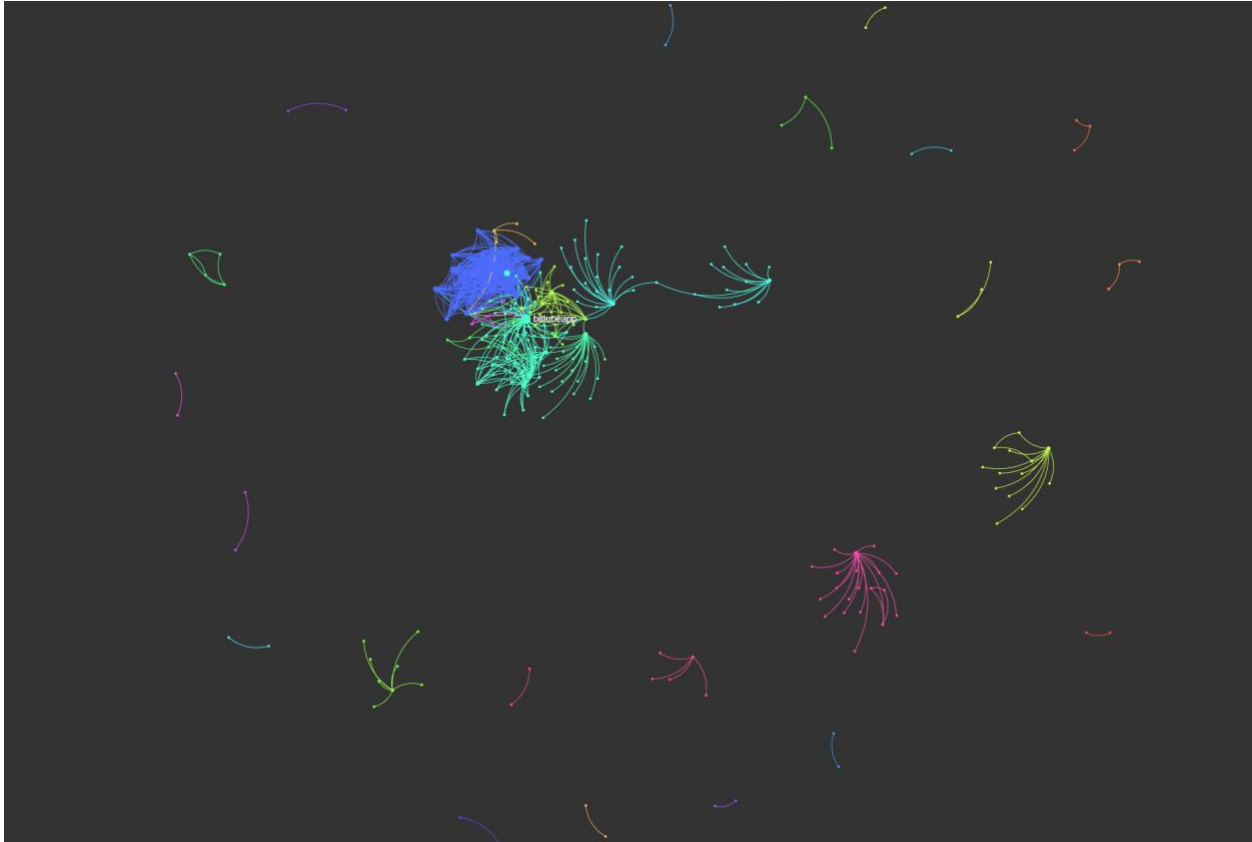
4.6.7 BitTube

Finally, the most interesting network graphic analysis for this study came from the decentralized alternative to YouTube. BitTube had a network diameter of 1, a centrality value of

0.21, and a modularity value of 0.64. Out of all the terms studied throughout this section, BitTube had the significantly highest degree of centrality, a value of 0.217, and the lowest value of modularity, 0.64. This indicates to this study that BitTube is the term that has the most amount of conversations that trends towards a few individuals as can be seen in Figure 25. Furthermore, it is also the term that has the least amount of division which indicates a higher likelihood of being composed of a few core group of nodes. This is important for the study to note as it indicates that BitTube is being discussed less from a diverse and divided population – and points towards its reliance on niche cryptocurrency users who produce and consume similar kinds of content. Whereas the data showed that the YouTube platform consisted of many different categories of content that individuals spanning many different areas of interest consumed, the study argues that as of 2019, BitTube has not yet amassed a wide variety of content consumers and producers. This means that in order to be considered ready for mainstream adoption, BitTube would have to be significantly more diverse in its user base. Once again, because the platform is not first to market, its attempt to reach mass adoption is ambitious to say the least and has the biggest hurdle to climb.

Figure 25

Network Analysis of BitTube



5.1 Sentiment Analysis

The sentiment analysis score, in addition to tweet quantity, geographic spread of users, and network analysis can help this study in determining the likely mainstream adoption for decentralized technologies. A higher share of positive discussion regarding a term, the more likely, this study argues, it is to be ready for wider adoption. To begin, the study starts with the two already adopted centralized platforms, Reddit, and YouTube.

YouTube's total tweets from January to December of 2019 were put through sentiment analysis. Tweets that were deemed to be neutral constituted 54.8% of the overall share, positive tweets 26.2%, negative tweets 12.8%, and 6.2% were not able to be evaluated.

On the other hand, tweets positively referencing the social platform Reddit accounted for 15.2%, negative tweets 18%, neutral tweets 66.5%, and those unable to be analyzed accounting

for 0.3%. Interestingly, this brings the study to continue along with the same argument that a decentralized platform has an increased likelihood of adoption if its centralized alternative gives it the environment to grow. In this case, the overall negative sentiment on Twitter towards Reddit serves as an indicator to this study that a decentralized platform could attempt entry in the space and is possibly why the Steemit platform has been able to amass a user base substantially higher than BitTube. Indeed, negative discussions towards the platform possibly point to dissatisfaction in regard to the governance structure of the company running the platform, some unpopular changes made to the interface, functionality, or an issue of censorship and moderation. These are all factors that need to be considered and come into play when a decentralized alternative attempts to unseat an already established centralized platform. On the other hand, the term Bitcoin contained 56.5% neutral discussions on Twitter, 23.1% positive, 16.3% negative, and 4.1% not able to be analyzed. This points to Bitcoin's community mostly conversing around topics such as newsworthy events and general updates to the network but is important to note as it serves as a basepoint to compare the decentralized alternatives.

Another important term that can provide the study with a comparable basepoint, SegWit's share of neutral conversations consisted of 41.7%, positive 32.8%, negative 24%, and 1.4% not able to be analyzed. It is interesting for this study to note that even though SegWit divided the community heavily before its implementation in 2017, the technological update has since been primarily discussed in a neutral and positive way. A reason for this may be due to its success in lowering the fees associated with Bitcoin transactions, and its fast-growing adoption rate. This helps put into perspective the arguments made previously in regards to SegWit, notably, that these individuals who hold a strong understanding of Bitcoin and decentralized technologies are more likely to discuss them in favorable terms.

Furthermore, the first of the decentralized alternatives, Steemit was able to distinguish itself from Reddit in regards to the overall sentiment of the conversation. In total, 49.2% was deemed neutral, an impressive 37.1% was positive, 10.1% was negative, and finally, 3.6% was not able to be evaluated. Compared to Reddit, Steemit's share of positive discussion was 21.9 points higher which indicates a higher degree of acceptance of the platform – and the indication that Steemit was possibly able to onboard users that were dissatisfied with Reddit. As this study argues, this leads to a higher likelihood of mainstream adoption and is perhaps why the other previous indicators in this study led to the same conclusion that Steemit was able to define itself in the news aggregation space by providing a new highly desired revenue model that its centralized competitor did not.

The final of the decentralized alternatives, BitTube was again able to distinguish itself from YouTube in regards to the overall general sentiment of the conversation. Neutral sentiment consisted of 46.9%, positive conversations accounted for 40.5%, negative 9.8%, and finally, 2.8% was not able to be evaluated. Compared to YouTube, BitTube's level of positive conversations was approximately 14.3 points higher leading the study to indicate that while these centralized platforms do hold a majority share of the user population, if individuals become increasingly dissatisfied and disenfranchised with them, a shift could occur where users migrate towards peer-to-peer decentralized platforms. To reiterate, generally, individuals who contained a strong understanding of decentralized technologies were discussing them using favorable language while the data analyzed for centralized platforms showed a substantial number of users were discussing it negatively.

The most impressive overall share of positive sentiment came from the term Lightning Network. The term was able to amass a total share of 56.6% positive conversations, 34.7%

neutral, 8.4% negative, and 0.7% not able to be rated. This is a further demonstration as to why this study argues that a decentralized platform that wants to increase its chances of adoption needs to incorporate a second-layer solution, like the Lightning Network, because of its already established positive role in the space. While building a social media platform on top of this technology is a new idea that this study proposes and advocates for, additional studies need to be conducted to identify the technical requirements and constraints that this might propose. As expected, future research should also conduct a qualitative analysis of the content in the tweets themselves in order to identify specifically what users are discussing, and which keywords appear most frequently. This would strengthen the certainty in which the study can conclude whether or not these decentralized alternatives are ready for mass adoption, and if the second-layer of the Bitcoin blockchain is ready to introduce a social media alternative.

Chapter 5: Conclusion

The study has extracted Twitter data to analyze the total quantity of tweets surrounding blockchain-based alternatives to centralized social media. The study explored specific terminology, the geography of where those users are located, network analysis, and sentiment analysis to provide an evidence-based stance for arguing the necessity of decentralized social media running via the second-layer. In this chapter, I will follow my conclusions with the best practice recommendations and avenues for future research.

The study argued that necessity plays a crucial role in the mainstream adoption of platforms. Because of this, in my opinion, and as seen in the adoptions of blockchain technology in Venezuela, until a time comes where a cataclysmic event happens within the space of centralized platforms, whether it be in relation to censorship, governance or data ownership and privacy, decentralized alternatives will always have an arduous journey ahead to increase their market share. When such a time comes when users decide to converge towards a decentralized platform, the Bitcoin and blockchain community will need to have a better alternative to propose. This study consistently argued that a true focus on the second-layer will be beneficial in the future – as opposed to a wide array of different decentralized blockchains all requiring different specifications and dedicated currencies depending on the use case. The results in this study all point to this being the best path towards adoption because Bitcoin and the Lightning Network are already far ahead in regards to the geographical spread of community members, the overall quantity of conversation, modularity, and centrality of their network, and overall online discussion sentiment. As was discussed, large third-party intermediators have demonstrated a consistent lack of ethical obligations towards the safekeeping of individual private data, and have shown the ways in which external influence can impact the rights of their users. In this way, the

migration towards decentralized alternatives is the next logical step to regain individual freedom on the internet.

Furthermore, this study has argued that a way in which decentralized platforms could increase their chances of adoption would be to forgo the complications with the creation of their own dedicated blockchain solution and adopt what this study proposes is the best proposition, a second-layer social platform built on the original Bitcoin blockchain. This would alleviate most of the major shortcomings of decentralized platforms that have been identified in this study, primarily, the absence of necessity for yet another specialized blockchain with a singular function, and the lack of awareness for decentralized alternatives. Since the results of this study demonstrated that individuals are increasingly trending to becoming interested in second-layer solutions rather than dedicated and specialized blockchains such as Steemit and BitTubes', and the quantifiable qualities of discussion surrounding Bitcoin remain consistently higher than that of non second-layer decentralized platforms, decentralized alternatives that want to succeed in the mainstream should forego control of their own dedicated blockchain along with their own dedicated cryptocurrency that powers it. This solution would have the advantage of decentralized platforms being able to market themselves along with Bitcoin and the second-layer instead of competing with them and further segregating themselves in the community.

Indeed, similarly to how YouTube and Reddit benefited from being the first to occupy the digital space of video sharing and news aggregation, Bitcoin has already benefited from being the first to occupy the space of blockchain and cryptocurrency. As a result, instead of competing with Bitcoin, decentralized platforms will need to instead integrate with it to build on the momentum and to increase their chances of gaining mass adoption. Furthermore, Bitcoin is

now so decentralized that it is not vulnerable to use in the kinds of takeovers discussed in the Steemit case.

As a last point, this study has questioned the broader notion of whether or not the mainstream public is ready for such a drastic shift into the decentralized social space. While the study identified a clear upwards trend in popularity for Bitcoin and second-layer technologies, total discussion surrounding centralized platforms is substantially higher than that of decentralized alternatives. Arguably, in order for a platform to be deemed ready for mainstream adoption, it would have to demonstrate its ability to pull users away from centralized alternatives and increase its market share in the respective digital space. Currently, decentralized platforms are struggling to amass a significant number of users that would make them competitive in the digital landscape. As a result, future research surrounding decentralized social media should focus on the ways in which a platform can enter a space and compete with pre-existing and established platforms. While this type of competition tends to favor incumbent platforms, ascendancy is occasionally possible for incoming platforms. For instance, Facebook entered and succeeded in the market where Myspace already dominated. decentralized platforms could study and adopt Facebook's strategies. This study identified geographic trends in adoption, identifying the regions of the world that have been adopting decentralized platforms. Future studies should explore geographic trends at a more micro-level in order to determine the sociological factors that play a role in adopting decentralized technology. Regions of the world that have been faced with banking crises and a collapse of their national currency could have higher levels of skepticism towards centralized platforms - and thus a higher likelihood of trending towards decentralized technology.

Lastly, future research should review corporate-led cryptocurrency projects such as Facebook's Libra in order to explore their adoption rate and marketing strategies - if they ever do come to fruition and pass regulatory approval.

While this study introduced the idea of social media platforms running on the distributed Bitcoin blockchain, the technological constraints and limitations surrounding this proposal would need further examination in order to determine the feasibility of such an endeavor. The technology currently exists to build such a platform, however, adoption is not simply a matter of technology: the sociological factors are stronger determinants than technology is shaping whether individuals will be willing to make the switch

Oftentimes, users do not think about how a technology or company is working in the background until it stops working in their best interests. More and more recently, members of the public have become aware that social media does not work in their best interest. Their privacy is increasingly diminished, their personal data is subject to data breaches due to poor safekeeping, and their freedom of expression and access to information is frequently censored. On January 3rd, 2009, an opportunity to redistribute power to the individual user presented itself through a peer-to-peer protocol that is able to broadcast data using any communication medium. Since the information that is distributed on the open Bitcoin network is uncensorable and open to anyone, social media platforms that run on the technology will not be financed by the sale of user data - and individuals who opt to use these platforms will benefit from an increase in individualism and freedom. As this study has determined, for most people, this concept and opportunity have not yet been communicated effectively and the technological bar for adoption is too high for participation by regular social media users. However, while the general public is not currently ready for such a shift, there will come a time, a catalyst moment -- as we have seen in regions of

the world where trust in centralized banks is low -- that will be impossible to ignore and which will spearhead the decentralized movement. It's not a matter of if, but, given increasing financial insecurity, a matter of when.

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