



Regulating The Bitcoin Ecosystem

Master Thesis Rishabh Kapoor (4184009)
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Title	Regulating The Bitcoin Ecosystem
Author	Rishabh Kapoor
Date	February 1st, 2016
Email	Rishabhkapoor8711@gmail.com
University	Delft University of Technology Faculty of Technology, Policy & Management
Program	Engineering and Policy Analysis
Section	Economics of Innovation
Graduation Committee	Chairman: Prof. Cees van Beers [Economics of Innovation] First Supervisor: Dr. Servaas Storm [Economics of Innovation] Second Supervisor: Dr. Filippo Santoni De Sio [Philosophy of Technology]

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Rishabh Kapoor

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Abstract

Bitcoin is a peer to peer decentralized virtual currency, released online through a research paper in 2008 by the unknown Satoshi Nakamoto . Around the world, many countries have cautiously taken minor initiatives to address the regulatory issues, due to its rising popularity. The regulation is not seen as complete, due to the nascent and novel outlook of bitcoins, requiring time for analysis and empirical evidence. The main research question that needs to be answered, is how can governance ideas be conceptualized to support technological decentralization while protecting against illegal activities? To answer this question a literature review is performed across academia, digital media and conferences/ independent authors. From this study, ideas for frameworks are consolidated, to effectively regulate bitcoins through coalitions, analyzed with game theory. This is complemented with a theoretical understanding of the technical, political, economical and ethical issues surrounding the bitcoin ecosystem.

The thesis is broadly divided into seven chapters, where initially an introduction is presented which presents the structure of the thesis, along with the research problem and its motivation. This is followed by an exploration of bitcoin's current framework, which forms the most important theoretical part of the thesis. Here, its system design, strengths, challenges and solutions to regulatory issues are detailed. Also, how bitcoin is being perceived globally across twenty nations, is presented. Being an economic system, there has been reasonable skepticism, as to its validity as a money system. This is presented in the next chapter, where its economic structure is first explored, which is followed by an analysis of bitcoin, from the perspective of both Austrian economics and Keynesian economics. Further, to understand the overall validity of a new system, the ethical impacts must be considered. This has been analyzed through two frameworks in this thesis. Firstly, as a large social experiment and secondly through a standard ethical impact assessment.

Also, bitcoin has always been portrayed in the popular press, as promoting decentralization. This is critically analyzed from classical ideas of noted humanitarian M.K Gandhi and British economist M.F Schumacher. As a follow up, a modern exponential technology framework presented by Singularity University, is offered as a comparison. Interestingly, it is observed that bitcoin excels in the material aspect of decentralization but struggles in the spiritual aspect, as detailed. The major regulatory solution offered in this thesis, is through coalitions among stakeholders. For clarity, seven crisis situations are highlighted with the different payoff's (relative power) among the different members assigned, with proper reasoning and a demo game explained. Finally, conclusions and favorable recommendations are drawn , along with sections on research limitations, future research and reflections. Also, an appendix section on the major digital media outlook, is presented for two years (Aug'13- Sep'15), to explain its popular portrayal and the opinion of the general audience.

Overall, it can be said that it is still early days for bitcoin and there are major critics in every domain, countering its future existence. Consistent issues with taxation, anonymity tools like TOR promoting illegal activities, its inherent economic value and price volatility exist. The internet as an information medium, is probably the only suitable precedent for bitcoin, which has been far more successful than anticipated. The benefits of bitcoin from exponentially lower transaction fees, global banking outreach, framework for decentralized asset ownership transfer and its ability to impact the Monetary Policy of ruling governments have been appreciated. With over hundred competing digital currencies, the question is certainly not if, but when they would be competitive with fiat currencies.

Keywords: Bitcoin, Cryptocurrency, Peer to Peer (P2P), Colored Coins, Game Theory Coalitions, Appropriate Technology, Technology Decentralization

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Chapter 1: Introduction

The Bitcoin journey is one marked by excitement, controversy, promise, hope and greed. A lot has been said over the past years, ever since a pseudonymous paper appeared online in 2008 by Satoshi Nakamoto, highlighting a peer to peer electronic cash system. It reinstated the possibility, that publishing a paper online (*outside any journal*) anonymously can significantly impact the world. This thesis is mainly inspired by trying to relate the events occurring in the bitcoin world to Economics, Public Policy and Ethics to discuss regulatory ideas and solutions.

As we stand on the shoulder of giants, it is very important to accept that without the Internet technology and the recent financial crisis, there would be no place for Bitcoins to begin with. After all, any disruption for its own sake has not lasted the test of time, be it the Internet Bubble in the early 2000s or the historic Dutch Tulip mania¹ which has always been a negative comparison base for bitcoin to begin with. Will bitcoin have the same fate or will something remain when all the big venture funding (*estimated \$800 million in 2014*)² for the startups dry up?

Bitcoin is a decentralized (*no central authority ratifying each transaction*) open source (*no owner*) peer to peer crypto (*driven by computer algorithms*) digital currency protocol (*rule based program*) which is the first of its kind globally to gain popularity. Its adoption is growing very fast to over 64,000 businesses (*October, 2014*) accepting it and user base of around 100,000 (*early 2014*) which is doubling every eight months for past three years with large growth in transactions (*List of Figures at the end verify this*). However, there are many dormant accounts and Satoshi dice (*popular gambling site*) accounts for a large number of small transactions (Badev & Chen, 2014). Overall, bitcoin wallets have grown from 765, 039 a year ago to 5.32 million³ (*June, 2014*) and predicted to increase to 8 million by the year end.

The major advantages offered are:

- Lower global transaction fee: Transmitting money for remittances globally, costs upto 12% through current services like Western Union. The African continent receives upto 50 billion dollars⁴ annually (*80% of African adults have no bank accounts*) in remittances. This could be carried out for free or 0.1% charge on average, through bitcoin's decentralized technology where money could be received as simply as an email.
- Framework for decentralized physical asset ownership transfer⁵: Transferring ownership of houses, cars, shares, bonds, commodities or any type of asset could be done without third party involvement virtually. By creating digital verification systems of bitcoin, both the money value (*represented by bitcoin*) and asset transfer (*represented by real asset*) could be verified on the universal public ledger (*blockchain*) of the bitcoin ecosystem (B. Y. J. Brito & Castillo, 2013)
- Impact on Monetary Policy action of the governing Central Banks: The fact that bitcoin is decentralized and cannot be increased or decreased in supply, to only support certain actions of

¹ Tulip Bulbs for Our Time: <http://www.wsj.com/articles/SB10001424052702304096104579240213383697076>

² Top Venture Capital deals of Bitcoin: <http://blog.genesis-mining.com/top-venture-capital-deals-of-bitcoin>

³ Analysis - Bitcoin shows staying power as online merchants chase digital sparkle:

<http://uk.reuters.com/article/2014/08/28/uk-usa-bitcoin-retailers-analysis-idUKKBN0GS0AQ20140828>

⁴ Bitcoin for the poor <http://www.economist.com/blogs/baobab/2014/06/cash-transfers-africa>

⁵ Smart Property, Colored Coins and Mastercoin <http://www.coindesk.com/smart-property-colored-coins-mastercoin/>

the government during crisis situations or otherwise, impacts how much power they can assert through monetary policy. Such actions can be performed by the Bitcoin Foundation (*NGO overlooking bitcoin's systemic sustenance*) based on discussion by the community (*with majority consensus*). Though by definition, the supply of bitcoin and rate of money supply is fixed by algorithms, which is also open source in authority. (Elwell, Murphy, & Seitzinger, 2015).

Overall, there is an optimistic belief that bitcoin could be the next big revolution in Economics and impact the current system to an incomparable level (Surda, 2011).

However, critics have been far and wide for bitcoin. The former Federal Reserve chairman, Dr. Alan Greenspan⁶ labeled bitcoin as a bubble lacking inherent value. Similarly, Nobel laureate Paul Krugman⁷ (*popular economist*) expressed issues over the bitcoin value, labeling it as 'evil' while siding as a conscientious liberal. Kaushik Basu⁸, World Bank economist called bitcoin a naturally occurring ponzi scheme (*fraud*) which is "hard to detect". He believes the main value of bitcoin, is in the lesson provided to central bankers on electronic currencies.

Further, online currencies are accused of using 5000⁹ times more power per transaction than VISA (*popular payment method corporation*) which isn't sustainable . A single bitcoin transaction could roughly power 157 American households, for a day. VISA processed near 58.5 billion transactions in 2013, using enough electricity to power 50,000 households. Through this metric, bitcoin was about 5,033 times more energy intensive per transaction. UNEP (*United Nations Environment Programme*) financial system sustainability expert, Jeremy McDaniels stated, "it appears there are significant challenges to ensuring that Bitcoin's growth minimizes environmental impacts." However, this has been countered as a scaling problem at the MIT (*Massachusetts Institute of Technology*) Bitcoin Expo¹⁰, 2015 by technologist Andreas Antonopoulos, due to bitcoin offering the highest international level of security as an upcoming currency. With further adoption, the costs and energy usage should drop, due to positive network effects.

In the startup world, Coinbase, a popular digital wallet company, got funded by \$25 million from leading venture capitalists in Silicon Valley, California. Further, Coinbase raised \$75 million in a series C round taking its total capital raised to \$106 million. Three of the world's respected financial institutions: NYSE (*New York Stock Exchange*), USAA (*United Services Automobile Association*) and BBVA (*Banco Bilbao Vizcaya Argentaria*) alongside former Citibank CEO Vikram Pandit and former Thomas Reuters CEO Tom Glocer invested in the firm. Coinbase on January, 2015 became the first regulated bitcoin exchange based in the US and supported by twenty four states. In January, 2014 Overstock.com¹¹ became the first major retailer in the United States with over a billion dollars in revenue to accept bitcoin. Also, Dish

⁶ Greenspan Says Bitcoin a Bubble Without Intrinsic Currency Value:

<http://www.bloomberg.com/news/articles/2013-12-04/greenspan-says-bitcoin-a-bubble-without-intrinsic-currency-value>

⁷ Bitcoin is Evil: http://krugman.blogs.nytimes.com/2013/12/28/bitcoin-is-evil/?_r=2&

⁸ World Bank Report: Bitcoin is a 'Naturally Occurring' Ponzi: <http://www.coindesk.com/world-bank-report-bitcoin-naturally-occurring-ponzi/>

⁹ Bitcoin accused of wasting shocking amount of electricity: <http://rt.com/usa/270550-bitcoin-energy-hog-critics/>

¹⁰ MIT Bitcoin Expo 2015 Day 1: <https://www.youtube.com/watch?v=llgjogLipvk>

¹¹ In First Day With Bitcoin, Overstock Does \$126,000 in Sales: <http://www.wired.com/2014/01/overstock-bitcoin-sales/>

network corporation¹² with about \$14 billion in annual revenue started accepting bitcoin payments in mid August, 2014.

Further, Ried Hoffman¹³, billionaire technology investor with early stakes in billion dollar companies like AirBnB, Facebook and Dropbox put \$20 million in Xapo, a bitcoin wallet and storage startup. He suggested three interesting aspects of bitcoin:

- An asset like digital gold
- Currency for transaction/trade
- Platform to build financial/other products

According to him, mass adoption of technology comes from catering to a real world need. While it is supportive what Overstock.com is doing for US customers, they already have credit cards and good systems. In places like Argentina, Ukraine and Russia there is real need and mass adoption could happen. However, in January, 2015 Bitstamp¹⁴, the third busiest exchange lost near 19,000 bitcoins worth roughly \$5 million (*at that time*) due to technical glitches. Earlier in 2014, Mt. Gox, the busiest bitcoin exchange collapsed after unnamed hackers, allegedly breached its systems embezzling about 850,000 bitcoin, worth close to \$450 million in funds at that time.

Further, in the developing world of Uganda¹⁵, a documentary showed the promise of bitcoin in being a breakthrough, for the near zero transfer rates, when compared to the current 12% by Western Union for the remittance economy. However, the weakness lied on needing local bitcoin buyers. This system can be more exploited by loan sharks¹⁶ (*if the community has not developed*), which was found to be the case. The scope is intense as upto 80% of African adults have no bank accounts and at least 16% use mobile platforms with the entire continent getting about \$50 billion¹⁷ in remittances. Also, bitcoin can support female empowerment¹⁸ and financial autonomy as certain South Asian countries require the husband or a male family member to co-sign for a female, for getting a loan.

In the Art world, elitist galleries decide the fate and value of many artists which has been popularly seen to show similarity with the power exerted by central bankers over the economy through monetary policy. The Startup, Cointemporary¹⁹ features artists and offers the option to pay in bitcoins. Also, startup Ascribe²⁰ based in Berlin, plans to tackle digital piracy which cost the Hollywood film industry

¹² U.S. satellite TV operator Dish Network to accept bitcoins: <http://www.theglobeandmail.com/report-on-business/international-business/us-business/dish-says-to-become-the-largest-company-to-accept-bitcoin/article18903747/>

¹³ Why Billionaire Investor Reid Hoffman Is Betting Big on Bitcoin: <http://www.entrepreneur.com/article/244859>

¹⁴ Bitstamp exchange hacked, \$5M worth of bitcoin stolen: <http://www.zdnet.com/article/bitstamp-bitcoin-exchange-suspended-amid-hack-concerns-heres-what-we-know/>

¹⁵ Bitcoin in Uganda: Empowering People: <https://www.youtube.com/watch?v=BrRXP1tp6Kw>

¹⁶ Bitcoin To Send Money To Your Brother In Uganda Would Be Awesome, If It Actually Worked: <http://www.forbes.com/sites/kashmirhill/2014/05/22/using-bitcoin-to-send-money-to-your-brother-in-uganda-would-be-awesome-if-it-actually-worked/>

¹⁷ Bitcoin for the poor: <http://www.economist.com/blogs/baobab/2014/06/cash-transfers-africa>

¹⁸ Bitcoin winning over women in developing countries?: <http://rt.com/op-edge/182144-bitcoin-women-developing-countries/>

¹⁹ Online Art Gallery Experiments with Bitcoin Payments: <http://www.coindesk.com/online-art-gallery-experiments-bitcoin-payments/>

²⁰ Bitcoin is the world's most dangerous idea. Really? <http://thenextweb.com/in/2015/05/11/bitcoin-is-the-worlds-most-dangerous-idea-really/>

\$3.3 billion in 2014. By tracking digital art through its entire journey, the owner can be properly compensated. Currently, over 60 artists have declared 2600 digital art works.

Globally, Netherlands²¹ shows high adoption for its size being home to about 5 percent of bitcoin internet nodes (*connections*). The software has been downloaded nearly 130,000 times which is one of the highest per capita globally. As major banks like BNP Paribas²², Societe Generale (*Soc Gen*), Citibank and UBS are looking to explore bitcoin, Bitpay (*major bitcoin wallet service*) has sponsored the St. Petersburg Bowl²³ (*national football game in the US*) to bring bitcoin in the mainstream. Also, Sacramento Kings became the first NBA (*National Basketball Association*) team, to start accepting bitcoin and San Jose Earthquakes soccer club started accepting bitcoins too.

Beyond just software²⁴, open source has a larger role to play in making sure everyone has access to its developments. From blueprints, recipes and rules; the aspiration is to make the underlying code shared across multiple people for contribution and access. This formed the initial research background.

1.1 Research Background

The author's interest in bitcoin was piqued on witnessing the global financial crisis, while accepting the growing inequality²⁵ in the world. In looking for alternative models, the initial hype around bitcoin, served as a gateway for exploration. The quantitative easing carried out in the US with bailing out of the 'too big to fail' banks in 2008, served as an impetus to understand how monetary policy could be misused, in the garb of systemic stability.

After studying basics of policy analysis and going deeper into Economics (*through coursework of the master's degree*), the risks with seeing it as an exact science with formulated analysis, surfaced after reading the texts of noted contrarian and Professor of Risk Analysis at NYU (*New York University*), Prof. Nicholas Nassim Taleb. Further, the documentary of noted historian, Niall Fergusson (*Harvard University*) 'The Ascent of Money'²⁶ gave an account of money/banking from the Jews to the Medici's to the Rothschild's to the Gold Standard and finally to the Breton Woods conference, which piqued the search for the next big evolution.

Also, weather bitcoin would be an 'appropriate technology' for society at this juncture, offered an interesting conjecture. Could it hold true to virtues of being appropriately scaled, environmentally sound, energy efficient and locally controlled? Was bitcoin it its fundamentals promoting sustainability? (Schumacher, 1973)

Further, personal experience in an internet business startup, gave a certain respect to the power of information technology in impacting systems. There was an understanding of how historically, the internet was seen as an anarchist drug supporting medium in the early 1990s, was technically very

²¹ Bitcoin Grabs Dutch Fancy as Bankers Mull New Technology <http://www.bloomberg.com/news/2014-05-29/bitcoin-grabs-dutch-fancy-as-bankers-mull-new-technolgy.html>

²² <http://www.coindesk.com/8-banking-giants-bitcoin-blockchain/>

²³ Bitcoin Lands NCAA College Football Bowl Sponsorship Through BitPay: <http://www.coindesk.com/bitcoin-ncaa-college-football-bowl-sponsorship-bitpay/>

²⁴ <http://opensource.com/resources>

²⁵ World Economic Forum warns of dangers in growing inequality: <http://www.reuters.com/article/2014/01/17/us-davos-risks-idUSBREA0F0H920140117>

²⁶ <https://www.youtube.com/watch?v=fsrtB5lp60s>

sophisticated to use, went through a major business bubble in the 2000s and currently supports the largest businesses and philanthropy organizations in the world. The exponential rather than linear impact of these systems (*in radically changing their environment*) was well understood. This gave a certain long term vision, to what bitcoin could be and put the current criticism in good faith, while directing sincere efforts towards addressing the public policy issues.

Finally, an interest in decentralization piqued, as bitcoin fundamentally operates without third party interventions. In this sense, the texts of noted humanitarian M.K Gandhi²⁷ served as an important base for the future. He did not believe in half-way house democracy or disinterested decentralization. The purpose had always been to not merely raise the standard of living, but the standard of life. Hence, the concentration of power in his view, distorts all democratic values.

Could bitcoin answer to all these issues as a solution of decentralization, just like the mistaken universal solutions of class struggles (*Karl Marx*) and human psychological neurosis (Sigmund Freud) (Schumacher, 1973)? This led to the research problem.

1.2 Research Problem

The purpose was to be innovative, rigorous yet critical of bitcoin (*due to the lack of a reasonable precedent*) while searching for the major research problems. This accelerated the difficulty of choosing a policy analysis tool which would be accurate yet holistic.

Any monetary system aspires to enhance the material functioning of society, while protecting against the illegal side effects. Issues of national security²⁸, fraud and drug abuse, are often seen to be more important than innovation. If innovation could be promoted while keeping the interests of the major stakeholders in line, policy issues could be managed well.

The major problem of bitcoin is a lack of centralized authority/issuer of currency (Nakamoto, 2008). This made contemporary central banks, governments, academics and financial industry experts vary of its side effects. Going through three major bubbles till date, did not help its cause, even though it grew relentlessly²⁹ during the period. The website 'Bitcoin Obituaries'³⁰ lists the heralded demise of bitcoin a total of 93 times up till now, by the major media houses.

There are five major facets which contributed to the final research question.

Firstly, could bitcoin encourage tax evasion (*once in the mainstream*), is a major concern due to it being a peer to peer currency (Marian, 2013). Tax departments globally tried classifying it as a commodity³¹

²⁷ Gandhian Political Decentralization-<http://www.mkgandhi.org/articles/politics1.htm>

²⁸ New York announces plans for bitcoin 'license' amid high-profile arrest: <http://rt.com/usa/bitcoin-regulations-new-york-320/>

²⁹ Coinbase CEO Brian Armstrong Shares His Vision For The Future Of Bitcoin
<http://techcrunch.com/2014/10/21/coinbase-ceo-brian-armstrong-shares-his-vision-for-the-future-of-bitcoin/>

³⁰ Bitcoin Obituaries: <https://99bitcoins.com/bitcoinobituaries/>

³¹ 2. Bitcoin regulation, here we come: Singapore clarifies tax policies
<http://venturebeat.com/2014/01/10/singapore-clarifies-tax-on-bitcoin-exchanges-and-sales/>

and a few went with currency³² while others banning³³ it/making it tax free³⁴ due to absent legality. Both has issues. Commodity classification creates issues of fungibility³⁵ and practical sales tax³⁶ application. While the currency definition, denies its role as a value asset and the subsequent income source that came from holding it. Also, bitcoin is being used more as an asset for speculative price rise, than for buying goods and services. Merchant adoption is increasing, as they do not have to hold the currency for long, with the digital wallet service bearing the major risk (Lo & Wang, 2014). Hence, as a side effect, the website 'Silk Road' became infamous for promoting drug purchase, which on being shut down initially by regulators, spawned multiple versions³⁷ of the initial self due to the anonymous payment system of bitcoin and web anonymity tools like TOR³⁸.

Secondly, the value of bitcoin is controversial, as it moved from pennies to above 1200³⁹ US dollars at its peak and currently trading near 400 US dollars, in a span of near two years. The issue of whether it has any value, has been a major academic scrutiny. According to Keynesian and Austrian school of economic thought, the medium of money must have inherent value before being used as a medium. This is further elaborated in Chapter 3: 'Parallel's with Economic Theory' section

Thirdly, how does bitcoin stand with regard to broader ethical impacts on society? Are they all positive or do they cause unquestionable damage.

Fourthly, the issue of weather this is true decentralization, rather than technological hedonism (Schumacher, 1973), is important to address with the world view of thinkers like M.K Gandhi and international organizations like the United Nations (UNDP, 1999). Also, the opinion of modern day technologists is essential. These factor became important once the emphasis was broadened to a sustainable prosperity of society.

Finally, practical solutions to actually regulate bitcoin were important. Many experts suggested its novel nature and lying outside traditional legislatures. However limited practical advice was given, on how countries and international organizations could deal with it.

These research problems lead to a unified research question (*with sub questions*) while avoiding a panacea oriented approach.

³² The Boring Bitcoin Report: May 19-26 <http://www.forbes.com/sites/perianneboring/2014/05/26/the-boring-bitcoin-report-may-19-26/>

³³ Ecuador Bans Bitcoin, Plans Own Digital Money
<http://www.coindesk.com/ecuador-bans-bitcoin-legislative-vote/>

³⁴ . Denmark Declares Bitcoin Trades are Tax-Free
<http://www.coindesk.com/denmark-declares-bitcoin-trades-tax-free/>

³⁵ How Israel Can, and Should, Become Ground Zero for Bitcoin
<http://www.coindesk.com/israel-can-become-ground-zero-bitcoin/>

³⁶ New IRS rules make using Bitcoins a fiasco http://money.cnn.com/2014/03/31/technology/irs-bitcoin/?_ga=1.149184880.714779418.1396415215

³⁷ MIT Bitcoin Expo 2015 Day 1, Talk by Charlie Lee (Founder, Litecoin):
<https://www.youtube.com/watch?v=llgjogLipvk>

³⁸ TOR Network: [https://en.wikipedia.org/wiki/Tor_\(anonymity_network\)](https://en.wikipedia.org/wiki/Tor_(anonymity_network))

³⁹ 2013: Year Of The Bitcoin: <http://www.forbes.com/sites/kitconews/2013/12/10/2013-year-of-the-bitcoin/>
China fuels Bitcoin surge to record high: <http://money.cnn.com/2013/11/12/investing/bitcoin-record-high/>

1.3 Research Question

The major research question came to be:

How can bitcoin be regulated while protecting against illegal activities and supporting technology decentralization?

Also, many sub questions got formulated as a natural progression. These are:

a. How could the issue of tax evasions be seriously managed keeping in mind its decentralized nature? *(Answered in Chapter 2)*

b. Does bitcoin have value? Is bitcoin 'money' and is it able to perform the unit of account, medium of exchange and store of value function? *(Answered in Chapter 3)*

c. What are the broader ethical impacts of the bitcoin ecosystem on society? How can they be improved? *(Answered in Chapter 4)*

d. Does bitcoin enable/enhance decentralization appropriately? *(Answered in Chapter 5)*

e. How can bitcoin be regulated? Is it compatible with bitcoin's inherent structure to be regulated through traditional methods? *(Answered in Chapter 6)*

These research questions lead to figuring out the research methods.

1.4 Research Methods

The two major research methods used were, Literature Review and Game theory analysis. For literature review three major sources were explored, as listed below.

Firstly, the book 'Small is Beautiful: A Study of Economics As If People Mattered ' by Dr. E.F. Schumacher (*British economist*) explored how smaller decentralized appropriate technology systems, are more beneficial for the larger society. Modern advanced technology which is ill adapted to the environment, often acts as a deterrent to overall well being.

Secondly, research papers in the field of bitcoins exploring its technology, economics and politics were studied from both reputed academic institutions and independent authors. Further, papers on decentralization from sources like M.K Gandhi , United Nations and open source communities, were also included. Overall, around seventy papers were screened with near fifty referenced.

Thirdly, outlook of the digital media over two years reviewing over a thousand articles, gave feedback of the industry, government and citizens. Though noisy and often non rigorous, the overall excitement, skepticism, optimism and fraud of the ecosystem was well communicated. These are chronologically detailed for two years (Aug'13- Sep'15) in the Appendix section at the end.

Finally, forming a policy analysis offered a choice for tools. As the future of bitcoin is highly unpredictable and it is the first of its kind, the author was keen to choose methods with minimum hypothetical's and extrapolations. Hence, game theory was chosen to offer an analysis for judging the

shifting power dynamics over different crisis situations, through possible governance coalitions. Interestingly, countries like Japan⁴⁰ have publicly announced the requirement of international coordination for regulating bitcoins and startups like CryptoVoter⁴¹ have emerged mimicking that role through decentralized voting. These understandings lead to the overall structure of the thesis.

1.5 Structure of Thesis

The thesis is organized to offer an overall theoretical and analytical view of the bitcoin regulation.

After an overall introduction, bitcoin's current framework is explored. Initially, the 'System Design' of bitcoin is explained keeping in mind its overall purpose followed by the 'Strengths', 'Challenges', 'Global Positions on Bitcoin' and 'Solutions'. Here the regulatory issues of bitcoin are discussed where current progress, bottlenecks and solutions are proposed, while taking feedback from both the digital media and academic literature. Interestingly, major stakeholders seem to collectively agree that there is potential while highlighting loopholes from all directions. The bottlenecks are mostly political not technical, which further increases the complexity of the analysis. This would be the most important section of the thesis, in understanding the importance and skepticism around bitcoin.

Being an economic system, exploring how bitcoin fits into the current ideologies from Keynesian to Austrian economics, is essential to understand, while addressing possible issues. This is carried out in the next section, 'Parallel's with Economic Theory', through theoretical assumptions and analytical tools which measure traditional aspects of the economy. An entire section is dedicated to this, for highlighting the importance of keeping economic thought side by side with technology innovation.

Next, an 'Ethical Impact Assessment of Bitcoin' is pursued for trying to analyze its ethical stance according to developed academic frameworks. Further, recommendations are offered to better align the negative and neutral ethical impacts. Ideally, feedback from major stakeholders (*as highlighted in Chapter 6 on Governance coalitions*) on the ethical framework, would be suggested. However, under constraints, ideas are presented through research materials for each ethical value.

The idea of technological decentralization is explored next, from the philosophy of M.K Gandhi. Bitcoin's possible role, as an enabler in decentralizing the monetary system as an 'appropriate technology', is explored, with regard to ideas of economist E.F. Schumacher. Modern ideas of open source systems and exponential information technologies, are also applied from institutes like Singularity University and selected academic references to access sustainability of the ecosystem.

Following this, an analysis of policy solutions is carried out in the this section, using game theory to form stable coalitions among the major stakeholders. This is tested against crisis situations, where power shifts are analyzed under circumstances of mistrust and failure of certain parties. A final best coalition isn't purposed, however the pattern of power sharing and institutional design for governance is discussed.

⁴⁰ Japan Pushes for International Effort on Bitcoin Regulation

<http://www.coindesk.com/japan-pushes-international-effort-bitcoin-regulation/>

⁴¹ A Solution To Bitcoin's Governance Problem: <http://techcrunch.com/2015/09/21/a-solution-to-bitcoins-governance-problem/>

Finally, the 'Conclusions & Recommendations' are given with sections on 'Recommendations', 'Research Limitation', 'Further Research' and 'Reflections'. This section tries to present a concluding stance while highlighting shortcomings and future directions.

Chapter 2: Bitcoin's Current Framework

This chapter broadly explores bitcoin's framework, currently from multiple dimensions. These include its systemic design, strengths, challenges, global positions on bitcoin and solutions. For clarity, the challenges have been divided into Technical, Legal, Economic and Governance challenges. Also, the positions of twenty nations are presented. Further, the sections are presented.

2.1 System Design

This section firstly explains the major system design factors of bitcoin. This is followed by certain issues found in the systemic design, to be in conflict with other ideas.

2.1.1 Main System Design

Bitcoin is a peer to peer digital crypto currency which is completely virtual, open source and requires no third party intervention. The different members (*nodes*) are linked on a digital network where they exchange bitcoins for commerce. A key pair (*public, private*) is given to each user, on purchase of a bitcoin. The public key is an address (*like email address*) which can be given to any person for receiving money. The private key is used by the owner for sending bitcoins. Having the first mover advantage and emerging as the most popular digital currency, bitcoin has inspired many different digital currencies with different algorithms. As of December, 2013 upto 35 such alternative⁴² coins had been registered with recognizable growth. Litecoin had emerged as the most popular alternative. As of December, 2015⁴³, at least 100 such currencies were trading with Ripple (*market capital near three hundred thousand US dollars*) having emerged as the most popular alternative to the majorly dominant Bitcoin (*market capital above six billion US dollars*).

The usage of cryptography to make information public rather than private, is different than the mainstream use of this technology. To test this vision, the alternative digital coins offer flexible solutions to specific problems. For example, Litecoin is four times faster in processing transactions and Dogecoin (*another digital coin*) offers a flexible growth rate of money supply growth (k). This helps adapt bitcoin in future and understand user preferences (Böhme, Böhme, Christin, Edelman, & Moore, 2014).

Further, bitcoins need to be generated by miners (*people analogous to those mining gold*) who use computational power to solve complex mathematical problems. They work to generate bitcoins, arrange the different transactions in a 'blockchain' (*chain of blocks*), do digital account keeping for the ratified transactions and help run the system efficiently. Their incentive is a small systemic change (*tip*) from the new bitcoin generated and the possibility of charging transaction fees, for helping the transaction go through.

From an economics perspective, the supply of bitcoin (*monetary base*) is capped via an algorithm at 21 million with nearly 15 million⁴⁴ already 'mined' computationally. This suppresses demand side management of goods and services is favored by Austrian economics theory. By negating the possibility of inflation (*of the value of goods & services*) and any quantitative easing, bitcoin could lead to a deflationary bias (*in the value of goods and services*). This conjecture is explored further in Chapter 3. Only supply side management (*of goods and services*) is possible (Surda, 2011). It is expected that by

⁴² Central Banks Warn of Bitcoin Risks

<http://online.wsj.com/news/articles/SB10001424052702303497804579239451297424842>

⁴³ Crypto-Currency Market Capitalizations: <http://coinmarketcap.com/>

⁴⁴ <https://blockchain.info/charts/total-bitcoins>

2140 the last 'satoshi'⁴⁵ or 0.00000001 of a bitcoin would be mined as the rate of production decreases exponentially over time (*roughly S shaped curve*) and the amount of computational power required to perform the mining work increases⁴⁶. Computationally, bitcoin has become around a hundred times larger (*in requirement and usage*) than the world's top 500 supercomputers⁴⁷ combined.

From an accounting perspective, bitcoin is a two column spreadsheet which is a simple 21st century version, where the first column represents each person who owns a bitcoin and the second column shows the total coins mined till now. This is pitted to upgrade the 600 year old double entry accounting system introduced by the Medici family⁴⁸ of Florence, Italy (*14th century*) for cross border payments.

As an open source⁴⁹ software, the source code is decentralized and can be improved by anyone in theory. 'Source Code' is the part of the software which can be used to change how the core system works. On the contrary, in a proprietary software this right is reserved only for the organization. Microsoft Word and Adobe Photoshop are such software's where users agree to not modifying the source code without the authors consent (*in the 'Terms & Conditions'*). Any user can recommend changes to the bitcoin online community, which are taken up on a popularity/support basis and implemented by the Bitcoin Foundation⁵⁰ (*Non Government organization maintaining bitcoin*). The next section discusses briefly, broad issues with bitcoin's systemic design.

2.1.2 System Design Issues

The bottlenecks for Peer to Peer (*P2P*) systems of information sharing, could apply in new ways to the bitcoin ecosystem due to the libertarian anarchist side of bitcoin users with the dark web⁵¹ TOR related and silk road⁵² users. The psychological thrill of getting something for nothing and not getting caught, could be a major reason for engaging in P2P illegal activities. However, as found in research, people are willing to obey rules, if they think it has been acted fairly. Many young people believe that the music recording industry is exploiting artists, hence there is a P2P moral cause as rich artists are very rich and most are poor. Similar logic could be applied to bitcoin due to the journalistic view of the financial system after the 2007 financial crisis, which assumed very rich bankers in a negative light as highlighted in the people protests henceforth. Proper group culture, ethics and leadership exist with strict hierarchy in P2P systems for the sake of maintenance and control. Also, an attribute of coolness is there. The idea of piracy traditionally belongs to the idea of making copies for profit. However, most file sharers don't really profit, as the cause is much higher.

Copying files had always existed in small numbers and somehow moving to large numbers, was the underlying motive, as the File Transfer Protocol (*FTP of the internet*) was designed by teenagers for

⁴⁵ Named after the anonymous founder: Satoshi Nakomoto

⁴⁶The computational difficulty in mining work is measured by the hash rate (Gh/s) dedicated to the network
[https://blockchain.info/charts/hash-](https://blockchain.info/charts/hash-rate?timespan=all&showDataPoints=false&daysAverageString=1&show_header=true&scale=0&address=)

⁴⁷ Bitcoin under pressure: <http://www.economist.com/news/technology-quarterly/21590766-virtual-currency-it-mathematically-elegant-increasingly-popular-and-highly>

⁴⁸ Will Bitcoin Finally Bring Down The House Of Medici? <http://techcrunch.com/2015/06/14/will-bitcoin-finally-bring-down-the-house-of-medici/>

⁴⁹ <http://opensource.com/resources>

⁵⁰ Bitcoin Foundation: <https://bitcoinfoundation.org/>

⁵¹ Small peer to peer anonymous networks: https://en.wikipedia.org/wiki/Dark_Web

⁵² Website used for drug trafficking which was shut down eventually:
[https://en.wikipedia.org/wiki/Silk_Road_\(marketplace\)](https://en.wikipedia.org/wiki/Silk_Road_(marketplace))

sharing files only. However, users are unable to see the difference between private property and public property which leads to Intellectual Property Rights (*IPR*) issues. Sharing has always occurred in private but doing it in public has issues (Sideri, 2003). The extent to which such illegal/legal sharing will apply to bitcoin's remains to be seen. The precedent is set, which cannot be denied.

District Attorney of New York County⁵³ suggested, that TOR anonymity tools (further *detailed in Section 2.3.3 Governance Challenges*) makes tracing bitcoin transactions very challenging. Tumbler technical systems which allow for switching IP (*Internet Protocol*) web addresses globally, should be taken very seriously. Many bitcoin related crime issues have national extradition requests. Hence, there is a global outlook for crime through bitcoin which cannot be taken lightly.

However Jeremy Liew⁵⁴, a partner at the venture capital firm, Lightspeed Venture Partners suggested, that bitcoin represents a very small part (0.5%) of the global illegal drug traffic. Hence, any claim of accentuating drug use is not very sound. If it is not taken mainstream, bitcoin will remain at the fringes with anarchist libertarians. When it will go mainstream, its pseudonymous nature (further *detailed in Section 2.3.1 Technical Challenges*) will become secondary to economic benefits. The challenge is to take it there, amidst all the skepticism and current drawbacks.

According to the United Nations Development Programme (*UNDP*) four forms of decentralizations exist. These are political, spatial, market and administrative which are often difficult to distinguish from one another. Bitcoin falls within all of them, only partially. It could be seen as an ASD (*alternative system delivery*) platform outside government control. However, according to definition, neither is it a private player nor is it a nonprofit organization, though it is maintained by a bitcoin foundation (*Non Government Organization*) and allows for private enterprises to exist on top of it too (UNDP, 1999). This helps to understand the possible classification of bitcoin by international organizations, thereby suggesting its outlier nature.

According to noted humanitarian, M.K. Gandhi, decentralized rule over centralized rule is the counter to western elitist representative democracy. Bottom up self governing public systems of panchayats (*local group of villagers*) are multi layered and autonomous, with highest power at the lowest level and least power at the top level (Mukherji, 2007). As a result, the panchayat becomes a basic unit⁵⁵ of democratic decentralization and the higher units will have to take advice, give expert guidance and co-ordinate the activities of the village panchayats for public service. These village panchayat's take responsibility⁵⁶ for almost all aspects of social, economic and political life of the community. From education, recreation, protection, agriculture, industries, trade & commerce to sanitation, justice, finance and taxation.

Hence, M.K Gandhi wanted village panchayat's to perform a variety of functions covering practically all aspects of the village welfare. On a practical note, how relevant these ideas are to bitcoin, remains to be seen as they were certainly not the explicit goal. This is seen through the fact that as a technical system, it encourages commerce to thrive ,through both public and private exchange of value and ownership of physical resources. The level to which it can create decentralized systems of governance, also depends on sophistication and ease of use, as technically the possibility exists. Open source protocol's like

⁵³ NYDFS PUBLIC HEARING REGARDING VIRTUAL CURRENCIES 28th January, 2014

Panel 1 Day 2- Law Enforcement and Virtual Currencies: <https://www.youtube.com/watch?v=6EPzoxTAcAI>

⁵⁴ NYDFS PUBLIC HEARING REGARDING VIRTUAL CURRENCIES 28th January, 2014

Panel 1- The Investor Perspective: The Future of Virtual Currencies:

<https://www.youtube.com/watch?v=TZW7R7FPIJY>

⁵⁵ <http://www.mkgandhi.org/articles/politics1.htm>

⁵⁶ <http://www.mkgandhi.org/articles/politics1.htm>

Colored Coins (*further detailed in Section 2.3.1 Technical Challenges*) allow for ownership of different types of goods like real estate, financial bonds, consumer goods etc. to be transferred in a decentralized manner. This could also be offered through proprietary networks built on bitcoin. Also, startups like CryptoVoter⁵⁷ have emerged mimicking the role of decentralized consensus voting.

Finally, on a positive note, decentralized systems like bitcoin are known to be more resilient towards high impact low probability events when compared to centralized systems (Taleb, 2013). Though they can be messier and more expensive to maintain initially, they are better protected in general against catastrophe and large scale systemic power abuse. This leads to the next section on the strengths of the bitcoin ecosystem.

2.2 Strengths

Interestingly, Accenture⁵⁸ company executives suggested that blockchain (*bitcoin database*) needs to evolve beyond the open system of bitcoin, into a private network of databases, to improve proprietary functioning. This is a reasonable derailment from its open source culture. A Venture Capital company report stated, that efficient blockchain technology could reduce banking infrastructure⁵⁹ costs by upto \$20 billion⁶⁰. This could be understood through the existence of a single online accounting ledger, for information/materials/money (*throughout the entire supply chain of any organization*) removing many layers of middle men. With an irrefutable single version of truth and history, operational efficiency could be dramatically increased while tackling possible systemic corruption.

However, at the 2015 MIT (*Massachusetts Institute of Technology*) Bitcoin exposition, technologist Andreas Anddaprolos⁶¹ explained clearly that the blockchain decentralized database is not possible without bitcoin or some currency to give value to those transactions. Also, the ability to create private networks on the bitcoin layer already exists through proprietary firms, that carry out business using a public ledger while protected by laws. Blockchain systems without bitcoin, would be tantamount to private entities having their own version of the public internet, rather than the public internet having all versions of private entities, which is presently the case. According to Fred Wilson⁶², Partner Union Square Ventures, it is possible that major Banks might promote a private owned version of bitcoin, which will probably die down.

Alternative digital coins like Ripple offer choices by creating private transfer networks where all types of currencies (*Euros/Dollars/Bitcoin*) etc. can be exchanged and seamlessly transferred. This is done using the ripple token money as a medium, which is traded on the stock exchanges. However, the currency is centralized and managed privately where the proprietors own a sizeable chunk of ripple coins. This

⁵⁷ A Solution To Bitcoin's Governance Problem: <http://techcrunch.com/2015/09/21/a-solution-to-bitcoins-governance-problem/>

⁵⁸ Accenture Directors: Blockchains Must Move Beyond Bitcoin
<http://www.coindesk.com/accenture-directors-blockchains-must-move-beyond-bitcoin/>

⁵⁹ Goldman Sachs: Blockchain is Ready For Centre Stage: <http://www.coindesk.com/goldman-sachs-report/>

⁶⁰ Barclays is experimenting with bitcoin's blockchain
<http://www.businessinsider.in/Barclays-is-experimenting-with-bitcoins-blockchain/articleshow/47782769.cms>

⁶¹ MIT Bitcoin Expo 2015 Day 1: <https://www.youtube.com/watch?v=llgjogLipvk>

⁶² NYDFS PUBLIC HEARING REGARDING VIRTUAL CURRENCIES 28th January, 2014

Panel 1, Day 1- The Investor Perspective: The Future of Virtual Currencies:
<https://www.youtube.com/watch?v=TZW7R7FPIJY>

provides a more adaptable model for financial institutions with the backbone decentralized technology of blockchains.

Further, understanding competition and the utility of multiple digital coins has been a major source debate. The technology allows for infinite versions to exist as long as there are miners to maintain it and users to support it. Litecoin founder, Charlie Lee⁶³ suggested interesting roles for various coins. As bitcoin has by far the highest/best security infrastructure and capital investment with public support, it could be used for the expensive transactions (*higher transaction fee*) in future, like a house/car transfer. Alternative coins like litecoin are designed to be four times faster than bitcoin with individualized mining so no centralized mining pools are specially advantageous. These could be used to pay for coffee and smaller transactions with smaller transaction fee.

Once all the different coins are mined by the individual algorithm limit, miners will work for transaction fees generated, which are reduced by all the competing miners to avoid possible exploitation . Also, all decentralized networks though politically popular, are always more costly than their centralized counterparts initially, till achieving large scale. This could be seen as both an advantage and a disadvantage.

Are bitcoins designed to promote such a decentralized ecosystem? Could self governing systems emerge with localized control as promoted by M.K Gandhi (*detailed in Chapter 5*)? Interestingly, even though bitcoin allows decentralized transfer, it promotes centralized players as well (*digital wallets, trading houses etc.*) offering proprietary services, just like on the internet. This synergy offers an essential balance. Is this balance between centralized and decentralized systems appropriate? This will be further detailed in Chapter 5.

The messages underlying bitcoin transactions can be used to transact a variety of software enabled transactions including transferring loans and physical properties while communicating with third parties. This works alongside its use as a currency or commodity depending on definitions (Shadab, 2014). As this transfer of physical asset ownership challenges existence of central clearing houses, the transfer fee is bound to decrease drastically as well.

Ultimately, the risk of volatility and inherent value of bitcoins, is taken by popular wallet services like Coinbase due to their financial backing and the current nonexistent use of financial derivatives (*detailed in Section 2.3.2 Legal Challenges*) for stabilizing its value. Hence, the user is not at extreme risks in these transfers. Most derivatives products of bitcoin, match current derivative products in the market and need less effort on the regulation front. However, their introduction is slow on caution which is inevitable and hopefully helpful. (J. Brito, Shadab, & Castillo, 2014).

Bishkek, Kyrgyzstan's⁶⁴ capital, recently opened Central Asia's only bitcoin ATM/terminal. The World Bank estimates that 31% of its GDP is generated through migrant remittances. Seven billion dollars were transferred through expensive Western Union service last year, which will hopefully be impacted through bitcoin and this new terminal. As Western Union is a centralized system, around 10-12% of the transfer amount is used as fee. With bitcoin this could be potentially free with fractional transaction fee (*applicable in future after all bitcoins are mined*) due to its decentralized nature. However, significant challenges exist in the bitcoin ecosystem which are detailed in the next section.

⁶³ MIT Bitcoin Expo 2015 Day 1: <https://www.youtube.com/watch?v=llgjogLipvk>

⁶⁴ Kyrgyzstan bitcoin experiment promises migrant workers big savings
<http://www.theguardian.com/world/2014/jul/08/kyrgyzstan-bitcoin-experiment-migrant-savings>

2.3 Challenges

The major challenges faced by the bitcoin ecosystem are broadly divided into four sections. These are technical challenges, legal challenges, economic challenges and governance challenges. Further, they are detailed.

2.3.1 Technical Challenges

A major critique of bitcoin is the technical sophistication required to currently operate, transact and secure oneself on the network. This would be comparable to earlier forms of email technology which required improving the GUI (*Graphic User Interphase*) to make it more user friendly. Similarly, a friendly bitcoin gateway is proposed between a node (*sender of a coin*) and a bitcoin client (*receiver*) which would work towards simplifying the entire operation like email technology (Syed & Syed, 2011). Many efforts of startups are geared towards making money transfers as easy as current internet transfers. After eight years of existence, there is still a lot of work to be done. According to a Google employee, bitcoin is bound to get better, stronger and easier⁶⁵ as it grows, which is the opposite of a centralized currency.

Privacy to carry out anonymous peer to peer transactions, outside third party inspection has been pitted as a major advantage for users, by the anonymous founder (Nakamoto, 2008). However, researchers ran the bitcoin software at the ETH Zurich University campus and found that almost 40% of the user profiles can be recovered to a large extent (Androulaki, Karame, Roeschlin, Scherer, & Capkun, 2012). This could be explained through the universal public ledger of transfers and public addresses of all users. Though tedious, transactions can be traced to a public address which gives rise to its pseudonymous nature rather than purely anonymous. To solve issues of privacy, computer science researchers initially suggested a proxy coin called 'zerocoin' to be generated each time a user transacts (*receives/sends*) any bitcoin. This helps to improve user privacy, as increased complexity of tracing transactions works to safeguard their identity (Miers, Garman, Green, & Rubin, 2013). Also, the overall digital identity of users currently managed through third party private corporations like Facebook, Twitter and Google can be safely managed⁶⁶ with bitcoin, through the public ledger making it more transparent and less vulnerable to data exploitation.

To solve the security issues of bitcoin, various technical solutions have been proposed specifically for problems with the requirement of a third party to preventing double spending and fraud. Technical backups of keys and coins, encryption and trusted paths offering third party benefits, have been outlined (Barber, Boyen, Shi, & Uzun, 2012). However, from a policy prospective these solutions do not seem satisfactory.

Researchers in Israel were able to trace sizeable transactions in the bitcoin ecosystem linking it to a major transaction of an entity sending 90,000 bitcoin's to itself, three times in self loops. This challenged the alleged anonymity of bitcoins and the validity of transaction rate being a good proxy for success of the currency (Ron & Shamir, 2012). As seen in the overall rise of transaction rate (*with and without popular addresses in List of Figures at the end*), the correlation with the amount of actual purchase of goods and services could not be found. Large number of small value transactions related with services

⁶⁵ Bitcoin: under the hood <http://www.bostonglobe.com/ideas/2014/05/24/bitcoin-under-hood/yP70yXBIBNLdOvjUqBOK1O/story.html>

⁶⁶ Block Chain Could be Bigger Opportunity than Bitcoin
<http://www.coindesk.com/vc-fred-wilson-block-chain-bigger-opportunity-bitcoin/> VC Fred Wilson

like Satoshi dice (*popular gambling site*) and many dormant bitcoin addresses shows bare usage for goods and services (Badev & Chen, 2014).

Digital safety is still being challenged as Virus pony⁶⁷ in February, 2014 lead to a compromise of over 700,000 credentials, 85 wallets with \$220,000 compromised. The financial amount compromised was low as the number of people using bitcoins is still in its infancy.

Programmable arbitration is also possible, through oracle like systems which can be fed financial data. These hold the promise of completely eliminating third parties. Using colored coins open source protocol⁶⁸, it's possible to legally transfer property by devoting a certain part of bitcoin (*arbitrary color assigned to the divided bitcoin ownership pie*) to represent an asset. For example luxury goods could be blue, consumer goods could be red and real estate orange. Every major real world asset can have a chip which would update ownership transferring cost in the blockchain (*bitcoin database*). Combining three tools of multi signature (*multiple people agreeing on one bitcoin transfer*), real world asset registration and programmable contracts, it is possible to majorly disrupt the entire financial system. Three parts of such an asset transfer could be a. identity creation b. marketing and Informing others on a decentralized network c. creating legal contracts for shares etc. through colored coins as assets (J. Brito et al., 2014).

For all the P2P anarchist tendencies, artists could be provided with the facility to feed off membership fee from P2P communities removing big label/monopolistic systems and providing good publicity on merit rather than public relations (Sideri, 2003). This role could be provided by startups using colored coins and other technologies built on bitcoin, removing the middle men for both information and financial communication.

Further, a startup Counterparty promises user's that they can engage in financial contracts without having to trust anyone to hold their funds or do their accounting. Also, Factom⁶⁹ maintains a permanent time stamped record of a company's data in the blockchain (*bitcoin database*), which can reduce cost/complexity of audit trails, managing records and complying with government regulations.

These second generation (*after the first generation of basic services like digital wallets and trading organizations*) of bitcoin platforms like Colored Coins, Counterparty and Factom support property transfer digitally based on public belief rather than a Supreme Court authority. Interestingly, current systemic functioning also depends on public relations and the political executive branch (*lead by the nation President*) support rather than any direct army⁷⁰ control. In detail, the exact policy functioning in nation states is through democracy and not dictated to citizens, where the idea of legality and law evolved into the science of jurisprudence. This has been supported at large, by citizens groups through the mass media and is hence the de facto governing principle. Hopefully, bitcoin would aid in the evolution of law without which there would be major legal challenges in operating such platforms.

Issues have been raised as to the energy intensive nature of bitcoin mining. However, the electricity consumption problem with mining is a human system factor to maintain open competition (Seng & Yew,

⁶⁷ Bitcoins, other digital currencies stolen in massive 'Pony' botnet attack

<http://www.pcworld.com/article/2101260/bitcoins-other-digital-currencies-stolen-in-massive-pony-botnet-attack.html>

⁶⁸ <http://coloredcoins.org/>: Startup which allocates a part of bitcoin for representing a financial asset

⁶⁹ Why Bitcoin Could Be Much More Than a Currency

<http://www.technologyreview.com/news/537246/why-bitcoin-could-be-much-more-than-a-currency/>

⁷⁰ Smart Property in Action

<https://bitcoinmagazine.com/15420/smart-property-action/>

2015). If collectively, we decide to let only a few people mine, the consumed electricity would drop tremendously as the difficulty of the complex math problems (*amount of computation needed*) increases with more miners, to balance the limited reward through game theory ideology. An empirical comparison with the resource intensive gold mining and fractional reserve banking isn't even possible, due to absent accurate energy statistics. However, on multiple accounts earlier, it has been stated by experts that decentralized systems are cheaper on scale as compared to centralized systems.

Finally, as the bitcoin network grows, the internet bandwidth required might increase on average. The people at a lower bandwidth, might not get access to all services which challenges the egalitarian nature of bitcoin per say, outlining the division between theory and practice. Surely, a balance would be ideal with the workable solution depending on amount of resources and a majority consensus (51%) which is essential for bitcoin on various levels (*detailed in 2.3.4 Governance Challenges*). Further, the legal challenges for the bitcoin ecosystem are detailed.

2.3.2 Legal Challenges

Similar to the Internet technology, bitcoin is designed by engineers not lawyers, hence it is bound to seem disruptive (Böhme et al., 2014). There is clearly an absence of codified law in the technology in case of consumer fraud (Böhme et al., 2014). For example, in credit card transactions, the facility of charge back exists where a client can complain to a third party (*bank/legal authority*) in case of a fraud and request for remittance. This seems absent currently in the bitcoin ecosystem.

To the fear of investors and honest customers, many bitcoin exchanges have shut down. A study conducted on 40 bitcoin exchanges over four years shows that 18 have since closed down causing sizeable accounts of customer money to be wiped out. A statistically relevant relationship was found between the exchange's transaction volume and its chances of being impacted. Less popular exchanges are more likely to shut down whereas more popular exchanges are more likely to experience a breach (Moore & Christin, 2013). As initial stages of TV, Radio, Voice over Internet (*Skype etc.*) and petroleum have shown, such patterns are common⁷¹ to innovative and disruptive technologies.

How peer to peer networks are perceived, is an important precedent for how the bitcoin payment network would be seen. The Information Society Directive, UK created a law to block materials at the control points for keeping a check on piracy. Similarly, a law exists in the European Union (*EU*) for protecting against copyright materials. Ironically, bureaucratic hassles currently undermine fair usage due to excessive legal protection and multiple access points. Certainly, it is easier to use pirated materials. Also, the psychological thrill of getting something for nothing and not getting caught could be a major reason for engaging in illegal P2P stuff (Sideri, 2003).

Bitcoin exchange itBit recently acquired a Bit License (*issued by the state of New York for business operation*) and expressed that it can operate legally across all 50 states. However, the California Department of Business Oversight was not ready to state whether a New York certificate applies to California as well. Another popular bitcoin wallet service Coinbase⁷² confirmed that the exchange was supported legally in 24 states including New York and California. However, the New York office expressed that the service did not have approval for their state.

⁷¹ Bitcoin 2013 Conference - Tuur Demeester - Why You Should Invest in Bitcoin:
<https://www.youtube.com/watch?v=K7LQu-eIOO0>

⁷² NY Backs Bitcoin Exchange. But It May Not Fly in California
<http://www.wired.com/2015/05/new-york-backs-bitcoin-exchange-may-not-fly-california/>

Taking a global lead in issuing licenses to startups for operating businesses in New York, the Bitlicense was positively received and given feedback on suitable amends. The issues with Bitlicense included requiring enhanced due diligence⁷³ on non-US citizens (*when compared to US citizens*). Definition of virtual currency used was too broad requiring the license's affiliates to allow the New York Department of Financial Services (*NYFDS*) to examine their facilities and records that are unrelated to the license's operations. Bitlicense update specifies, that individuals holding bitcoin for personal use, software developers, merchants accepting bitcoins, loyalty programs and gift cards owners will not need to hold a bitlicense. Also, the bitcoin currency was accepted as part of the capital and the record keeping time was reduced from 10 to 7⁷⁴ years, as obtaining extensive addresses and transaction data for all parties is not feasible.

Tom Robinson⁷⁵, Co-Founder of Elliptic, the world's first bitcoin insurance vault in London, and board member of the UK Digital Currencies Association suggested that minor steps towards the new digital regulation are a stamp of approval from the government. Also, "the UK should privatize the pound and replace it with bitcoin", expressed the Professor of Economics at Durham University⁷⁶. He explained that 'private money' (*explained further in Chapter 3*) existed earlier as well and was shut down due to political protectionism. However, with bitcoin the only difference, is that the government cannot shut it down due to its decentralized nature and they are well aware of that.

Virtual currencies are also seen to be outside the purview of the governing Bank Secrecy Act (*BSA*) in the US, as it applies to currencies issued by nation states only. Also, the Bitcoin protocol cannot be regulated like a regular money transmitter and as a normal bank, since there is no fractional reserve banking with a valid reserve. Bitcoin should ideally also have a parallel to the federal insurance issued by FDIC (*Federal Deposit Insurance Corporation*) in the US for safety in case of a run on the system like the financial crisis of 2007 (Tu & Meredith, 2015).

Interestingly, the 'European Goods Law' does not cover bitcoin like systems. Electronic money rules also do not apply to bitcoin there. Bitcoin cannot be classified as money remittance as well. It falls outside the payment system directive too. European Union law does not even imply the possibility of a decentralized currency. Hence with all the sub laws, it is not possible to include bitcoin and full regulation is not possible in the region (Shcherbak, 2014).

Houman Shadab⁷⁷, Professor at New York University (*NYU*) Law School explained that the Commodity Futures Trading Commission (*CFTC*) regulations, are for speculative markets and should stay away from regulating bitcoin initially. Also, bitcoin and its derivatives among users should be treated like any other commodity derivative. However, the CFTC did not comment on this. A journalists⁷⁸ view point, suggests

⁷³ BitBeat: Chinese Bitcoin Exchanges Weigh In on BitLicense in Lawsky Letter:

<http://blogs.wsj.com/moneybeat/2014/08/20/bitbeat-chinese-bitcoin-exchanges-send-letter-to-lawsky/>

⁷⁴ New York Is Ready With Revision of Bitcoin Regulations

<http://www.forbes.com/sites/tomgroenfeldt/2014/12/18/new-york-is-ready-with-revision-of-bitcoin-regulations/2/>

⁷⁵ Britain to regulate bitcoin exchanges: <http://timesofindia.indiatimes.com/tech/tech-news/Britain-to-regulate-bitcoin-exchanges/articleshow/46623991.cms>

⁷⁶ Privatise the pound and replace it with bitcoin, says free-market thinktank

<http://www.theguardian.com/technology/2014/jun/17/bitcoin-privatise-pound-free-market-thinktank>

⁷⁷ How Regulators Should Approach The Bitcoin Derivatives Market

<http://www.coindesk.com/regulators-approach-bitcoin-derivatives-market/>

⁷⁸ The Boring Bitcoin Report: May 12-19 <http://www.forbes.com/sites/perianneboring/2014/05/20/the-boring-bitcoin-report-may-12-19-a-not-so-boring-week-in-review/>

that CFTC's most impactful nod would be allowing hedging and derivative products of bitcoin. We should see many Wall Street Investors enter this space henceforth.

The major problem with a money transmitter status for people transacting in bitcoin, is that anyone can be acquitted for even sending money to a family member for tax purposes and others (FinCEN, 2013). The Federal Reserve Bank, US says that it has limited power and the Financial Crimes Enforcement Network (*FinCEN*) is stepping in places like New York. However, in other countries like India, France and Singapore it is the Central Bank that is stepping in (Szczepański, 2014).

Comcast, a major multinational media company⁷⁹ in 2013 admitted to blocking P2P software 'Bit Torrent; under network management which was challenged by the FCC (*Federal Communications Commission*). The FCC concluded, that Comcast had been blocking P2P application against current guideline. It further added that the hallmark of weather something is reasonable or not, is if the provider is willing to disclose to its customer what it is doing. Comcast did not reveal, that it was actively blocking Bit Torrent. There is a no blocking rule for lawful content but the issue remains that it should be lawful (Ruane, 2013). Same thing could happen with the bitcoin network as well, if the illegal activities remain and things start getting blocked privately. This further challenges the issue of net neutrality and the definitions of what is legal when shared.

The major issue of preventing double spending (*owner sending money to a fake account or a receiver providing service without receiving bitcoins*) via possible theft, is prevented as each transaction is verifiable by a completely public ledger⁸⁰. Only after a minimum set approval from the network miners is it ratified. Seen from the perspective of trust in technology according to its designer, this system eliminates the need for third party intervention like a central bank or legal authority (Nakamoto, 2008). However legally, the jurisdiction of the central banks have not been defined for this system.

The irony of bitcoin, is that it was initially pitched to challenge the power of central banks, but it needs very centralized intermediaries like wallets, exchanges, payment processors to function properly, apart from the other private players to come along in future (Lo & Wang, 2014). Hence, as an ideology decentralization and centralization mix is always observed and maybe desired. In the United Nations Development Programme (UNDP) definitions, it was found that they prefer decentralized governance over decentralization. The major reason for this is that decentralization should complement centralization and not replicate it. Hence, avoiding many utopian world views (UNDP, 1999). This is practically seen in bitcoin. Further, the economic challenges of bitcoin are listed briefly which are explored in detail in Chapter 3.

2.3.3 Economic Challenges⁸¹

Reputation based trust is the main economic administrative system in Peer to Peer (*P2P*) networks, which is valid for both the miners and users of the bitcoin ecosystem (Lee, 2003). P2P networks are in general far more tolerant against failures and shutdowns due to everyone being a client and server simultaneously. BitTorrent is the most popular P2P system with 40% of the global traffic geared towards it. It is a hybrid P2P network due to central servers (*points*) existing for administrative responsibilities. Hence, it has lower fault tolerance than a pure P2P network without any central point (Hong-Kong-

⁷⁹ <https://en.wikipedia.org/wiki/Comcast>

⁸⁰ Ledger: A record in which commercial accounts are recorded

⁸¹ further detailed in Chapter 3: Parallel's with Economic theory

Government, 2008). In this regard, Bitcoin would be a pure P2P network and in time maybe more popular than BitTorrent, due to possibility of asset & value transfer other than pure information. With proprietary companies emerging on top of the bitcoin layer, it is possible to have extensive centralization which will hopefully be accounted for with private capital and public regulatory methods. It would be less fault tolerant as well, having both the free and proprietary parts. How the economic system of trust works with bitcoin remains to be seen (Hong-Kong-Government, 2008).

Violation of Economic Gresham's law by Bitcoin is a proposed argument. Bad money eventually sources out good money and a group of 'unethical/selfish' nodes (*computers*) could easily wipe out the entire network stealing honest resources and collapsing the system. They could start by stealing power from electrical networks and ultimately outcompeting honest miners (Güring & Grigg, 2011). These are low probability Black Swan⁸² risks, which should not be neglected in any case.

It's hard to calculate the value of bitcoin from traditional quantity theory of money, as it defies traditional economics in the quantitative metric sense, through the money supply being fixed. Prominent Bitcoin Investor Andreessen Horowitz⁸³ explained, that bitcoin has the concrete value of a single slot in a finite sized public cryptographic ledger, through which value can move for transacting goods and services. The total bitcoin ledger has value, corresponding to the value and velocity of transactions that will run through it in future. Hence, by extension each slot in the ledger has fractional value determined by the total number of slots. In detail, this basically refers to how the blockchain (*bitcoin database*) would have businesses/open source protocols, providing facilities of commerce to its users. The ability to provide this access (*using bitcoin by default to create value*), gives it value without needing any 'intrinsic economic value'. The quantitative metric for this value is based on the total value of goods/services transacting on the service per unit time. This could be divided by the number of bitcoins transacting at that moment, to give a unit value per time. However, it must be emphasized that this is a theoretical assumption, yet to be tested for statistical significance due to limited data available. Further, one such empirical model, using the previous year's data to arrive at statistical significance, is explained in Chapter 3. The market listed value has been calculated on its demand and supply, which is subject to change moment to moment.

As an opposition, Nouriel Roubini⁸⁴, lecturer at the Stern School of Business suggests that bitcoin is a ponzi scheme. Veteran investor, Warren Buffet⁸⁵ warned investors that bitcoin has no intrinsic value and can effectively transmit money just like cheques and money orders which have no value. Further, the governance challenges of the bitcoin ecosystem are detailed.

⁸² Black Swan is defined as an high impact low probability event: https://en.wikipedia.org/wiki/Black_swan_theory

⁸³ Bitcoin Battle: Warren Buffett vs. Marc Andreessen

<http://www.forbes.com/sites/kashmirhill/2014/03/26/warren-buffett-says-bitcoin-is-a-mirage-why-marc-andreessen-thinks-hes-wrong/>

⁸⁴ Economist Nouriel Roubini Slams Bitcoin, Calls it a 'Ponzi Game' <http://www.coindesk.com/economist-nouriel-roubini-slams-bitcoin-calls-ponzi-game/>

⁸⁵ Bitcoin Battle: Warren Buffett vs. Marc Andreessen

<http://www.forbes.com/sites/kashmirhill/2014/03/26/warren-buffett-says-bitcoin-is-a-mirage-why-marc-andreessen-thinks-hes-wrong/>

2.3.4 Governance Challenges

To start off, it is a very tough task to tell regulators⁸⁶ that algorithms are being potentially developed to replace them. The solution is to just keep building honest systems as blockchain (*bitcoin database*) has incorruptible truth, with one unique public version of transaction history since its inception on every linked computer. However, politics⁸⁷ surely exists in bitcoin as well.

The question of who actually controls bitcoins and takes governance decisions has been a major source of debate. According to Gavin Anderson, Chief Scientist⁸⁸ at the Bitcoin Foundation, the community gives suggestions which reach consensus, which are further implemented by five core developers in the foundation. The skepticism of whether the five coders act partially or impartially towards any suggestion was not objectively cleared. Further, in a recent interview⁸⁹, Gavin suggested that initially the bitcoin founder used to take all the decisions, then a small group of people took that responsibility. Now, the major issue comes when a large group are keen on participating in day to day decision makings.

Making laws to support bitcoin's financial transactions, are more important than the debate over bitcoin's legal stature or judging its strength and viability with current systems (Descôteaux, 2014). The first step is to take bitcoin to a threshold level of acceptance. Strangely, no one can control it, other than everyone together by consensus. Three types of majority consensus operating in bitcoin have been outlined. Firstly, the participants must agree on the rules to determine validity of transactions. Secondly, they must agree on which transactions have occurred in the system. Thirdly, they must agree that the currency has value (Kroll, Davey, & Felten, 2013). These consensus principals have been known to operate tacitly allowing bitcoins to be mined by miners and its value being traded in the market. Prof. Felton⁹⁰ at Princeton University suggested that if a majority attack happens, the honest members of the bitcoin network should form an alliance and ignore the transactions of attackers. Majority attack will be very expensive, but a hostile nation attack is very possible. Banning systems is definitely not the solutions as anonymity tools like Tumbler and TOR, can always create a fierce opposition.

The first major governance challenge is to build a 'system of trust' which can enable a nurturing community, ensuring safety and taking into account various risks, opportunities, rights and responsibilities. This needs people/peers in the network to trust each other like Ebay's buyer/seller ratings which pioneered P2P finance. Second, is building a level of trust with the public, especially in the context of regulation, as P2P services intersect more and more with the real world (*e.g. companies like Airbnb, Uber having peer to peer models*). Third step is developing trust within the platform. As more and more activities move online, trust is needed, that they are doing it in good faith and backed by fair policies. These are similar issues, governments grapple with in developing public policy and strangely current web platforms look a lot like governments. Also, web platforms are not bound by the requirements and responsibilities of public institutions. Hence, they compete as different platforms and

⁸⁶ Fellow at Coincenter Advocacy Group: Regulation & Policy MIT Bitcoin Expo 2015 Day 1:

<https://www.youtube.com/watch?v=llgjogLipvk>

⁸⁷ Speaker number 9: Core Developer of Bitcoin Foundation: MIT Bitcoin Expo 2015 Day 2:

https://www.youtube.com/watch?v=96ULIHhia_Q

⁸⁸ MIT Bitcoin Expo 2015 Day 2: https://www.youtube.com/watch?v=96ULIHhia_Q

⁸⁹ A Solution To Bitcoin's Governance Problem: <http://techcrunch.com/2015/09/21/a-solution-to-bitcoins-governance-problem/>

⁹⁰ NYDFS Virtual Currency Hearings: Panel 3 Day 2- The Academic View on Virtual Currencies:

<https://www.youtube.com/watch?v=poMdkTU9aRk>

have different rules which can be the basis of user choice (e.g. *it's easier to move from Facebook to Google than from US to Canada*).

Regulation 2.0⁹¹ is a framework for governments in a networked world, to engage with. In our current world, regulators are required to give permission to do things. In Regulation 2.0, as long as actions can be reported openly, people are free to innovate and operate. However, they are accountable to live up to the rules and the data reported can be measured against those rules.

With regards to mining, concerns have been raised about centralized mining pools. After mining all the theoretically available bitcoins, the miners would charge transaction fee as an incentive (B. Y. J. Brito & Castillo, 2013). Ghash.IO⁹² has emerged as the largest mining pool where people combine computing resources and share mining rewards. Theoretically, control over 51% of the mining operations on the decentralized bitcoin network would give an entity the power to accept or reject transactions into the blockchain. However, the organization has repeatedly stated that there are no intentions to execute a 51% attack. They agree that mining should be completely decentralized but accepts no guilt over being the number one mining pool. Similarly, Cointron (*another mining pool*) had over 51% of the Litecoin (*another digital coin*) network computing power (*hash rate*) and no 51% attack ever occurred. But, it is a centralized point of failure which should be avoided. Interestingly, bitcoin prices sank 2% as the 51% level⁹³ was achieved once by Ghash.IO. The crisis was soon resolved as Ghash.IO agreed to remove some of its resources, which stabilized the ecosystem.

A major factor challenging bitcoin's acceptance as legal tender, is the requirement of paying taxes. Hence, it is suggested, that governments should stop worrying on competition from digital currencies and focus on the true main issues of anonymity and consumer protection. The (*Organization for Economic Co-operation and Development*) OECD representative further suggests in the working paper, that the governments should not lose power over the currency system and monetary policy. The government always decides what is legal or not and has monopoly over taxation. As historically was done with the gold standard by closing it, similar action can be taken by the government to take control over virtual currency power, if it grows to challenge the status quo and stability (Blundell-wignall, 2014).

Practical problems do exist in enforcing tax collection unless all movements of ordinary citizens in bitcoin are tracked (Marian, 2013). The Internal Revenue Service (*IRS*) in the US is treating bitcoin like property, which means that bitcoin investors, holders, miners are like stock investors. This could create an electronic black market like the cash economy, according to Joshua Blank⁹⁴, Tax professor at New York University (*NYU*). The Tax Policy Center (*research center*)⁹⁵ expressed that, "Nobody in their right mind would ever comply with that regulation". The IRS would be unable to get all the transaction

⁹¹ These are extracts taken from a lecture given by Mr. Fred Wilson, Managing Partner, Union Square Ventures:
<https://www.youtube.com/watch?v=R43OKYmGbhU>

⁹² Bitcoin Mining Pool Ghash.io Is Unapologetic Over Risk Of Theoretical 51% Attack
<http://www.cryptocoinsnews.com/news/bitcoin-mining-pool-ghash-io-is-unapologetic-risk-theoretical-51-attack/2014/06/12>

⁹³ Bitcoin Prices Plunge As US Government Prepares To Auction Off Huge Stake
<http://www.businessinsider.in/Bitcoin-Prices-Plunge-As-US-Government-Prepares-To-Auction-Off-Huge-Stake/articleshow/36455199.cms>

⁹⁴ Bitcoin Is Property, Not Currency, in Tax System: IRS <http://www.bloomberg.com/news/2014-03-25/bitcoin-is-property-not-currency-in-tax-system-irs-says.html>

⁹⁵ New IRS rules make using Bitcoins a fiasco http://money.cnn.com/2014/03/31/technology/irs-bitcoin/?_ga=1.149184880.714779418.1396415215

information along with the sales tax applicability issue. For example, buying a 2 dollar coffee⁹⁶ with bitcoin bought at 1 dollar would trigger 1 dollar in capital gains tax for coffee drinker and 2 dollar gross income for the coffee shop. Hence, trying to regulate bitcoin is like trying to regulate the many headed hydra (*with no central head*) in Greek Mythology, according to Prof. David Andolfatto⁹⁷ also Vice President at St. Louis Federal Reserve Bank.

Also, cryptocurrencies (*digital currencies like Bitcoin*) are being seen as tax havens for fraud, due to their inherent anonymity and difficulty in linking IP (*Internet Protocol*) address to the real world⁹⁸ information, with technologies like ToR⁹⁹ network which are designed technically to keep off any surveillance. The government must find ways to incentivize taxpaying further and regulate such tools effectively. A major issue with the bitcoin network, is that nothing can be enforced until all major movements are tracked which goes against the decentralized and open source nature of bitcoin (Marian, 2013). Maybe, the governments should be given some system key to impact monetary and fiscal policy and manage an emergency of electronic currencies (Hayes, Gillespie, Daly, Grippo, & Johnson, 1996)? However, as stated by the authors, bitcoin's impact on monetary policy is currently limited due to small influence and market size (*List of Figures at the end*) and the governing body can easily sustain monetary policy through open market transactions (*selling/buying*) with their currency reserves to impact interest rates in the suitable direction (Szczepański, 2014).

Innovative upgrades to bitcoin always have political issues. A side chain paper¹⁰⁰ for bitcoin was recently released, allowing for the existence of a central and side chain in the main bitcoin protocol for seamless transfer between the two. The underlying bias of some ideas being more important to fit into the main blockchain while independent ones existing on the side, is a potential cause of conflict. Also, floating transaction fees for bitcoin was proposed to create priority for certain transactions over the others. 'Smart fees'¹⁰¹ says Bitcoin Chief Scientist Gavin Anderson (*member of Bitcoin Foundation NGO*) helps create priority and not employ same resources for different size of transactions. Whether the priority would be a purely technical or political decision remains to be seen.

For policy action, it has been suggested to be adaptive in nature, rather than rigid due to similarities with the Internet system (Yee, 2014). The participants in bitcoin should have freedom to influence regulation just like with Visa and MasterCard companies from which better regulation ideas might emerge. The EFTA (*Electronic Fund Transfers Act*) is the primary law in the US, governing electronic currencies with the historic Stamp Act (1862), also available which only grants the US government the right to print currency. Hence, this makes bitcoin outright illegal. However, this law has historical precedence. Travelers cheques could have provided the most accurate precedent, but in their case the

⁹⁶ Bitcoin Slips In The Wake Of The IRS's Tax Decision <http://techcrunch.com/2014/03/30/bitcoin-slips-in-the-wake-of-the-irss-tax-decision>

⁹⁷ Federal Bank VP: Bitcoin Threat Means Banks Must 'Adapt or Die' <http://www.coindesk.com/federal-bank-vp-bitcoin-threat-means-banks-must-adapt-die/>

⁹⁸ This difficulty of locating the actual person behind a particular IP due to the Tor network mixing IP's globally has been re-iterated by Richard B. Zabel, Deputy U.S. Attorney for the Southern District of New York during the NYDFS PUBLIC HEARING REGARDING VIRTUAL CURRENCIES January 28-29, 2014: <http://www.totalwebcasting.com/view/?id=nysdfs>

⁹⁹ What is Tor? A beginner's guide to the privacy tool: <http://www.theguardian.com/technology/2013/nov/05/tor-beginners-guide-nsa-browser>

¹⁰⁰ Coinbase CEO Brian Armstrong Shares His Vision For The Future Of Bitcoin <http://techcrunch.com/2014/10/21/coinbase-ceo-brian-armstrong-shares-his-vision-for-the-future-of-bitcoin/>

¹⁰¹ Bitcoin Core Development Falling Behind, Warns Bitcoinj's Mike Hearn <http://www.coindesk.com/bitcoin-core-development-falling-behind-warns-mike-hearn/>

issuer takes liability which is also missing for bitcoin (Smith & Wiison, 1997). Also, with the money transmitter definition for bitcoin users by the FINCEN (*Financial Crimes Enforcement Network*), even sending money to family members comes under the tax radar (FinCEN, 2013). In the next section, the positions taken by different countries on bitcoin is represented.

2.4 Global Positions on Bitcoin

The global responses to bitcoin can be broadly divided into four groups. From *no action taken to limited clarification* to *imposing limitations* on the virtual currency to finally offering *complete recognition* (Tu & Meredith, 2015). Below, the responses are detailed.

TABLE 1: GLOBAL POSITIONS ON BITCOIN

S.No	Country	Status
1.	France	Limited clarification
2.	England	Limited clarification
3.	China	Imposing limitations
4.	New Zealand	Limited clarification
5.	Denmark	Limited clarification
6.	European Union	Limited clarification
7.	Canada	Limited clarification
8.	Hong Kong	Limited clarification
9.	Australia	No action taken
10.	Bolivia	Imposing limitations
11.	Ecuador	Imposing limitations
12.	India	Limited clarification
13.	Finland	Complete recognition
14.	Sweden	Limited clarification
15.	Israel	Limited clarification
16.	Spain	Complete recognition
17.	Netherlands	Limited clarification
18.	Germany	Complete recognition
19.	Singapore	Complete recognition
20.	Denmark	Limited clarification
21.	United States	Limited clarification
22.	Russia	Limited clarification

Further, specific remarks and comments are detailed in serial order.

The Bank of **France**¹⁰² issued warnings about bitcoin risks and also argued¹⁰³ that bitcoin be seen, as a payment provider. The French¹⁰⁴ authorities asserted that bitcoin related revenues are taxable.

¹⁰² Central Banks Warn of Bitcoin Risks:

<http://www.wsj.com/news/articles/SB10001424052702303497804579239451297424842>

The Bank of **England**¹⁰⁵ played down its significance due to fledgling status in the markets.

China banned financial institutions from handling bitcoin transactions limiting it to the virtual world, so that it does not interfere with their monetary policy. The three major Chinese financial institutions banned bitcoin transactions which include China Construction Bank and Bank of China¹⁰⁶. Also, Chinese insurance companies¹⁰⁷ were banned from trading insurance entities in bitcoin.

Authorities in **New Zealand** and **Denmark** also issued warnings to protect consumers from fraud citing concerns.

The **European Union**¹⁰⁸ issued warnings against bitcoin's legality. 'Bitcoin is not a good alternative to the Euro', said Yves Merch¹⁰⁹, Board Member of the European Central Bank. However, more than 4900 payment terminals opened up in Ukraine¹¹⁰ in 2014 (*to buy bitcoin for cash*). Romania (*the second poorest country in European Union*), got its first bitcoin exchange in mid 2014 which is operated by the National Credit Bank, Romania¹¹¹. Also, very recently in October 2015¹¹² European Union's top court explained that bitcoin should be treated as any other legal transaction involving currency, bank notes or coins. Hence, it should be exempt from sales taxes within the 28-country bloc.

The **Canadian** Central Bank (*currency department*) wrote in the Bank of Canada¹¹³ review, that there are risks to the overall financial stability, if bitcoin becomes a significant means of payment.

Prof. KC Chan¹¹⁴ of the Financial Services and Treasury Bureau said that bitcoin isn't legal tender for **Hong Kong**. It is negligible in scale and impact, so the government is not considering it.

¹⁰³ Bitcoin Battle: Warren Buffett vs. Marc Andreessen

<http://www.forbes.com/sites/kashmirhill/2014/03/26/warren-buffett-says-bitcoin-is-a-mirage-why-marc-andreessen-thinks-hes-wrong/>

¹⁰⁴ Bitcoin Regulation Roundup: Booze Ban, Les Taxes and Bank Musings <http://www.coindesk.com/bitcoin-regulation-roundup-booze-ban-les-taxes-bank-musings/>

¹⁰⁵ Central Banks Warn of Bitcoin Risks:

<http://www.wsj.com/news/articles/SB10001424052702303497804579239451297424842>

¹⁰⁶ Bitcoin takes a beating in China as Tencent's epayments service and two major banks pull the plug

<http://www.techinasia.com/bitcoin-takes-a-beating-in-china-as-tencents-epayments-service-and-two-major-banks-pull-the-plug/>

¹⁰⁷ Bobby Lee of BTC China Explains Why China is #1 for Bitcoin: <http://onbitcoin.com/2013/12/11/bobby-lee-btc-china-explains-china-1-bitcoin/>

¹⁰⁸ Could Bitcoin's frothy venture funding dry up?

<http://www.pcworld.com/article/2082700/could-bitcoins-frothy-venture-funding-dry-up.html>

¹⁰⁹ The Boring Bitcoin Report: May 19-26 <http://www.forbes.com/sites/perianneboring/2014/05/26/the-boring-bitcoin-report-may-19-26/>

¹¹⁰ 5,000 Terminals Across Ukraine Now Offer Bitcoin for Cash <http://www.coindesk.com/5000-terminals-across-ukraine-now-offer-bitcoin-cash/>

¹¹¹ Bitcoin catches on in tech-savvy Romania- <http://timesofindia.indiatimes.com/Tech/Tech-News/Bitcoin-catches-on-in-tech-savvy-Romania/articleshow/39232207.cms>

¹¹² EU's highest court exempts Bitcoin currency from sales tax: <http://www.businessinsider.com/ap-eus-highest-court-exempts-bitcoin-currency-from-sales-tax-2015-10?IR=T>

¹¹³ Bank of Canada: "Unstable" Bitcoin could pose risk to global financial system

<http://www.straight.com/blogra/645336/bank-canada-unstable-bitcoin-could-pose-risk-global-financial-system>

¹¹⁴ Hong Kong Says No To Regulation Of Bitcoin (For Now) <http://qnta.net/2015/03/hong-kong-says-no-to-regulation-of-bitcoin-for-now/>

The Reserve Bank of **Australia's**¹¹⁵ head of payment policy Anthony Richards suggested, that the digital currency has no real issue due to limited use in the country. However, the Co-Founder of a startup Bit Trade Australia said that the 10% GST (*Goods and Service Tax*) currently enforced by the government on its transactions forces user's offshore. A lack of proactive support for the bitcoin ecosystem was suggested.

The central bank in **Bolivia** (*El Banco Central De Bolivia*¹¹⁶) banned bitcoin, treating it as illegal. Bitpagos (*Bitcoin startup*) CEO Sebastian Serrano suggested, that as one of the poorest countries in South America, it's quite sad. In the US it is observed that the merchants want to immediately convert bitcoins to dollar in order to avoid risky exposure. However, in Latin America, the exact opposite is seen. Silicon Valley based startup Bit Pagos¹¹⁷ will take their local dollars and give them bitcoins. This provides an escape route for citizens with strict currency controls. 'Latin America is an ideal staging ground for bitcoins as citizens don't trust governments' expressed Mauro Betschart¹¹⁸ (*Co-Founder of Moneero, a Bitcoin-oriented company*).

Ecuador¹¹⁹ banned the Bitcoin currency and plans to create a state electronic currency for efficiency.

The Reserve Bank of **India**¹²⁰ (*RBI*) stated being unsure of bitcoins with major exchanges being shut down in the country. It violates the country's laws as only the government has a right to print currency. Indian based bitcoin startup Laxmicoin¹²¹ halted actions due to the RBI's previous raids on bitcoin exchanges. Though it was backed by Silicon Valley in California, the business is taking it slow.

Finnish¹²² representative expressed that bitcoin is not a currency. It is a commodity which needs to be taxed.

The authorities of **Sweden**¹²³ also issued warnings about bitcoin risks.

The Bank of **Israel**¹²⁴ also explained that bitcoin is not legal tender.

¹¹⁵ Reserve Bank of Australia Favors Hands-off Approach for Bitcoin Regulation

<https://bitcoinmagazine.com/19999/reserve-bank-australia-favors-hands-off-approach-bitcoin-regulation/>

¹¹⁶ Bolivia's Central Bank Bans Bitcoin <http://www.coindesk.com/bolivias-central-bank-bans-bitcoin-digital-currencies/>

¹¹⁷ BitBeat: Why Bitcoin's Scoring in Argentina <http://blogs.wsj.com/moneybeat/2014/06/25/bitbeat-why-bitcoins-scoring-goals-in-argentina/>

¹¹⁸ Why Bolivia Really Banned Bitcoin <https://coinreport.net/bolivia-really-banned-bitcoin/>

¹¹⁹ Ecuador Bans Bitcoin, Plans Own Digital Money <http://www.coindesk.com/ecuador-bans-bitcoin-legislative-vote/2>

¹²⁰ RBI cautions users of Virtual Currencies against Risks http://rbi.org.in/scripts/BS_PressReleaseDisplay.aspx?prid=30247

¹²¹ Launch of Indian Digital Currency Laxmicoin Postponed Following Raids <http://www.coindesk.com/laxmicoin-struggles-to-launch/>

¹²² Bitcoin Judged Commodity in Finland After Failing Money Test <http://www.businessweek.com/news/2014-01-19/bitcoin-becomes-commodity-in-finland-after-failing-currency-test>

¹²³ Bitcoin Turns Into Art as Sweden Rejects Creative Currency: <http://www.bloomberg.com/news/articles/2014-01-21/bitcoin-becomes-art-as-swedish-taxman-rejects-creative-currency>

¹²⁴ Israeli Regulators Issue Joint Warning on Cryptocurrencies <http://www.coindesk.com/israeli-regulators-issue-joint-warning-cryptocurrencies/>

Spanish¹²⁵ authorities surprisingly decided, that bitcoin is to be treated as cash not commodity for tax purposes.

Former President of the **Dutch** Central Bank¹²⁶ explained that bitcoin would eventually die.

The Bank of **Germany** also argued, that bitcoin be seen as a legal financial instrument which should be taxed like other commodities(Descôteaux, 2014).

In **Singapore**¹²⁷, the supply of bitcoin is seen like the supply of services with the GST (*Goods services tax*) applicable on companies in the business of exchange. Hence investments by individuals/companies for buying goods/services through bitcoin are capital in nature and automatically taxed.

Denmark's¹²⁸ tax authority stated that bitcoin can't be taxed as it is not real money.

Senator Joe Manchin¹²⁹ in the **United States** was negative on bitcoin asking it to be banned while the Democratic representative Jared Polis supported bitcoin by accepting it for political donations. The US states of Kansas and Texas already issued, that bitcoin isn't real money. Also, relevant US laws like EFTA (*Electronic Funds Transfer Act*) have no place for currencies not issued by a federal authority (Smith & Wiison, 1997).

The **Russian** authorities¹³⁰ softened their negative tone on bitcoin, into a wait and watch mode. They suggested that systems can't be rejected because of using virtual currencies. The next section suggests some solutions for the many challenges faced by the bitcoin ecosystem.

2.5 Solutions

Adaptive (*dynamic*) style of policy making is described to be more suitable due to the disruptive nature of bitcoin. Traditionally conservative regulators cannot classify bitcoins as either commodity, currency or a payment network. Hence, there is a general apprehension, but this system resembles the Internet in its growth and technical architecture of decentralization and disruption (Yee, 2014).

The loss of controlling/regulating far outweighs benefits in a P2P environment using techniques like cost benefit analysis as growing decentralization means lesser intermediaries. Bottom up regulation strategies like adaptation, resiliency and finally prohibition should be used if needed. Promoting education and legalizing might be of great help to start with. The inherent requirement of regulation in many issues might go to the public trust through lessening intermediaries (J. Brito et al., 2014).

¹²⁵ The Boring Bitcoin Report: May 19-26 <http://www.forbes.com/sites/perianneboring/2014/05/26/the-boring-bitcoin-report-may-19-26/>

¹²⁶ Forget Tulip Mania, the Netherlands is Leading Bitcoin Innovation: <http://www.coindesk.com/the-netherlands-leading-bitcoin-innovation/>

¹²⁷ Bitcoin regulation, here we come: Singapore clarifies tax policies: <http://venturebeat.com/2014/01/10/singapore-clarifies-tax-on-bitcoin-exchanges-and-sales/>

¹²⁸ Denmark Declares Bitcoin Trades are Tax-Free <http://www.coindesk.com/denmark-declares-bitcoin-trades-tax-free/>

¹²⁹ Congressman Jared Polis Accepting Bitcoin Donations Following FEC Ruling <http://www.coindesk.com/congressman-jared-polis-accepting-bitcoin-donations-following-fec-ruling/>

¹³⁰ Russia Softens Stance on Bitcoin <http://online.wsj.com/articles/russia-softens-stance-on-bitcoin-1404305139>

The Chamber of Digital Commerce in the United States revealed that it intends to form a political action committee (PAC)¹³¹ to lobby for the bitcoin industry interests in Washington D.C. and provide campaign donations. The (*Financial Crimes Enforcement Network*) FINCEN¹³² in the US recently issued that bitcoin miners are not under regulation watch. Also private investors using bitcoin for personal gains, automatically fall under capital gains tax, hence not needing fresh regulation efforts.

With the money transmitter definition current by FinCEN in the US, even sending money to family members comes under tax radar (FinCEN, 2013). This has been looked into both as changes suggested to the Bit License in the US and solved¹³³ to some degree as holding private investments of bitcoin and local mining has been removed from the tax radar.

Bitcoin is organized in three layers of the logical, user and information. The logical layer consists of the technical code and the user layer, is one which interacts with the users and is mostly concluded to be harmless. Regulators should take support from the private digital money exchanges operating in the information layer to trace illicit activities. These illicit activities are quite small at the user layer according to the author. (Yee, 2014). Money laundering is unlikely to reach a large scale currently, due to the current infant scale of bitcoin. Also, the co-operation from exchanges needed to convert into mainstream currencies and the public nature of all bitcoins act as deterrents to this (Szczepański, 2014).

According to the author, Know your Customer (KYC) regulations should be conducted at the edges of the bitcoin system to offer least obstruction to the systemic functioning. Blacklisting users goes against the decentralized tenant of bitcoin so not acceptable to many in the community (Möser, Böhme, & Breuker, 2013). Also, Fred Wilson¹³⁴, partner at the venture capital firm Union Square Ventures suggested to regulate at edges and not on how the system works.

Elliptic¹³⁵, British Bitcoin storage startup, offers Federal Deposit Insurance Corporation (FDIC) type insurance with support from derivative products to cover users, in case of any systemic loses. This had been cited as a major drawback for the bitcoin system. Also, Silicon valley based startup, Xapo raised \$20 million to become the Fort Knox¹³⁶ of Bitcoin by building secret vaults deep inside the mountains on multiple continents. This works by creating cold (*offline*) storages for bitcoin incase of enemy threats or viruses which would theoretically improve privacy and security concerns.

The ability to charge fraudsters under commerce laws for selling bad mining machines, could in principle be used for bitcoins as well. Securities and Exchange Commission (SEC) in the US deemed investments purchased with bitcoins as securities. Since bitcoin is a form of money which can be used to buy goods and services, the SEC can charge against ponzi schemes around bitcoins. Also, not registering a trading business where bitcoin can be used as a security can lead to charges (Elwell et al., 2015). It is also

¹³¹ Chamber of Digital Commerce to Form Fund for Pro-Bitcoin Politicians

<http://techcrunch.com/2014/08/23/san-francisco-open-exchange-aims-to-be-the-e-trade-of-bitcoin/>

¹³² FinCEN Declares Bitcoin Miners, Investors Aren't Money Transmitters

<http://www.coindesk.com/fincen-bitcoin-miners-investors-money-transmitters/>

¹³³ http://www.dfs.ny.gov/legal/regulations/revised_vc_regulation.pdf

¹³⁴ NYDFS PUBLIC HEARING REGARDING VIRTUAL CURRENCIES 28th January, 2014: Panel 1- The Investor

Perspective: The Future of Virtual Currencies: <https://www.youtube.com/watch?v=TZW7R7FPIJY>

¹³⁵ For Bitcoin, Secure Future Might Need Oversight

<http://www.nytimes.com/2014/03/06/technology/personaltech/for-bitcoin-a-secure-future-might-require-traditional-trappings.html?hpw&rref=technology>

¹³⁶ Fort Knox is a US Military base where the major gold for valuation of the US dollar is stored. Currently, 147.3 million ounces are stored. http://www.usmint.gov/about_the_mint/fun_facts/?action=fun_facts13

possible to treat bitcoin like a company security with minimum case to case basis regulation (J. Brito et al., 2014).

Interestingly, the merchants have found short term solutions of dealing with bitcoin volatility by using the price in dollars, a time limit of 10-15 minutes and dealing with transaction irreversibility using gift cards in case of quality issues or customer dissatisfaction (Lo & Wang, 2014). Hence, Bitcoin can be easily used as a currency despite volatility issue as only investors with deep pockets care about volatility and consumer needs it for a short time only; as suggested by Prof. Susan Anthey¹³⁷, Stanford University.

Hence, as a conclusion it is seen that managing tax evasions risks with bitcoin's decentralized nature, has not been solved to an adequate manner. Experts mentioned in this chapter have suggested, that without keeping a close eye on every transaction and person; ensuring complete tax collection would be difficult. This would be seen as technically challenging, with its decentralized structure/philosophy along with anonymity tools like TOR, which could offer extremely strong resistance. However, with insistence through a rule of law and governance coalitions (*detailed in Chapter 6*), middle ground solutions seem feasible. Optimists have suggested, that the government should be able to pitch for individual projects on the bitcoin network, just like contemporary crowd funding operations by citizens and foundations. This could be seen as a favorable evolution of the mandatory taxation, as nothing can be enforced on the bitcoin network, that does not have a majority (*51% consensus*). The next chapter details the relevant economic theories and their parallel's with bitcoin.

¹³⁷ NYDFS PUBLIC HEARING REGARDING VIRTUAL CURRENCIES 29th January, 2014: Panel 3 Day 2- The Academic View on Virtual Currencies: <https://www.youtube.com/watch?v=poMdKtU9aRk>

Chapter 3: Parallel's with Economic Theory

This chapter provides an in-depth economic analysis of bitcoin. Starting with its present economic structure, it further presents the parallel's with two major economic school of thoughts; Keynesian economics and Austrian economics. Finally, issues are addressed as explored with the two schools of thought and bitcoin's position with regard to it.

3.1 Economic Structure

Here, the economic structure of bitcoin will be explained. Traditionally, money has been classified as commodity money, representative money and fiat money. Commodities have been used as money from tally sticks to precious coins. Representative money has been explored as a token/piece of paper which inherently has no value but can be exchanged for things having value in their time like gold, silver and even tobacco. Fiat money is money issued by a government having legal backing. Popularly, Bitcoin is seen more like as commodity money and fiat money, with side effect of causing deflation in the prices of goods and services in future (Shcherbak, 2014).

Similar to the historic use of cigarette as both a currency and commodity in prisons, bitcoin can be used as both too. The cigarette could be smoked as a commodity or used as a currency by passing it around, as it was found to be having inherent value. For trading firms, bitcoin is mainly a currency having value enough to demand market prices against other currencies. For digital commodity exchanges, bitcoin is mainly a commodity as it can compare with other commodities like Sugar, Salt, Gold, Silver etc. on prices. In economics rather than jurisprudence (*science of law*) this contradiction makes sense. Hence, no new accounting standard is needed (Seng & Yew, 2015). Also, there isn't a major theoretical need for individuals to give elaborate financial reporting. It was even stated, that if the Russian Rubble which has a comparable fluctuation/volatility can be considered as a currency, so can bitcoin (Seng & Yew, 2015). According to Prof. David Andolfatto¹³⁸ (*Simon Fraser University*) also Vice President at the St. Louis Federal Reserve Bank, this accounting is performed by miners who carry out communal service of record keeping along with mining and verifying transactions. He had referred to bitcoin as a stroke of genius, foreseeing a strong need for banks to evolve and adapt to this new phenomenon. Being a supporter of the decentralized and cost efficient peer to peer structure, he is positive about bitcoin adoption.

In the gold standard era, banking panics caused by an inelastic currency supply, lead to the creation of the Federal Reserve Bank in the US being an organization for managing their national monetary policy interests. However, bitcoin is inelastic as well with unknown power of central banks, so the problem is not entirely solved and seems to be a U-Turn according to the authors (Elwell et al., 2015).

The fact that bitcoin has a fixed supply of 21 million and it is divisible till the 8th decimal is not understood in the true light. It is not possible that we would run out of money anytime soon and incase the peak is near reaching in the future, the open source community could find solutions and change the algorithm as it is an arbitrary cap chosen to fix the supply and reduce the impact of the business cycles of boom and bust. Similarly, if the deflation threats grow beyond a point, the open source code of bitcoin could always be tweaked by the community. It isn't publicly made clear (*though discussed in the*

¹³⁸ A Fed Economist Explained Something About Bitcoin That Almost Nobody Understands
<http://www.businessinsider.in/A-Fed-Economist-Explained-Something-About-Bitcoin-That-Almost-Nobody-Understands/articleshow/33386726.cms>

open forums) as to how much of the code can be changed which in theory can be changed entirely. This could be to avoid the infinite changes possible and propel initial growth. There is no parallel as an open source economic project to analyze how such crisis situations could be managed better. The popularity of Linux (*Open source Computer Operating System like Windows 7*) which was invented in 1991 and is currently used by 94% of the world's top 500 supercomputers¹³⁹ shows the possibility of mainstream structural co-ordination and existence outside proprietary control. Also, as the bitcoin network grows, the cost of changes and failure grows due to large transaction and businesses resting on it.

The k percent Milton Friedman rule which is a monetary theory ideology, states that the central bank must increase the money supply by a constant percentage every year, to match the business cycles & growth of the economy and prevent excessive inflation. This application is partially built into bitcoin (Böhme et al., 2014). The bitcoin supply currently increases by around 0.6% a year (*subject to change by the S shaped exponential curve of growth*) which has, however been critiqued to cause an inherent deflationary bias to the value of goods and services priced. This is because of the lack of structural adaptability to the growing or contracting economy. If the economy grows faster than the bitcoin money supply rate, its currency price will rise and the goods/services price will fall leading people to hoard and save more, which could cause deflation (Szczepański, 2014). Whether, this deflation would actually occur, depends on the price model and factors giving value to bitcoin, which are debatable. It is possible, that incase the bitcoin velocity of transactions increases to counteract its smaller money supply, the bitcoin price rise and deflation of goods and services never happens. This would be possible, incase bitcoin velocity is significantly related to its price, which has been proved through one model for the last year (*explained below*).

How and whether, this periodic systemic feature would further cause a 'deflationary death spiral', is certainly of concern. In this hypothetical case, the economy would spiral into an indefinite deflation due to excessive pessimism and falling prices. As people expect prices to continue dropping or with rising unemployment and an environment of stagnated growth, the pessimism further grows. Finally, the economy, particularly when debt levels are high, spirals downwards in aggregate output, demand and employment (Brooks & Quising, 2002).

As an empirical model, researchers at Temple University (DeLeo & Stull, 2014), used a year of data, to arrive at statistically significant independent variables impacting the price of bitcoin.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \mu \text{ where,}$$

Y = Price of Bitcoin

X₁ = BDD = Bitcoin days destroyed (*Related to Bitcoin Velocity*¹⁴⁰)

X₂ = PG = Price of gold (*Measure of gold reserve significance*)

X₃ = IR = U.S. Dollar Inflation rate

X₄ = GT = Google trends metric (*Measure of Bitcoin Online Popularity*)

¹³⁹ Linux is the quiet revolution that will leave Microsoft eating dust:<http://phys.org/news/2014-06-linux-quiet-revolution-microsoft.html>

¹⁴⁰ The concept of velocity, derives from the 'Quantity Theory of Money', where the velocity of money is assumed to be constant. However, in the case of the bitcoins, the velocity of money is not constant and is measured by the amount of bitcoins spent in each transaction.

$X_5 = T =$ Number of transactions (*Measure of actual usage for goods/services*)

$X_6 = Q =$ Quantity of Bitcoins in circulation (*bitcoin supply*)

$\mu =$ error term

The variables Bitcoin days destroyed (*BDD*), Google trends metric (*GT*), and Bitcoin transactions (*T*) were found to be significant. Variable *BDD* (*amount of time, bitcoins remains unspent*) has the highest significance on a 99% level whereas *GT* and *T* have on a 95% level. As a conclusion, it was found that the higher the bitcoin transactions, bitcoin popularity on Google searches and bitcoin velocity; the higher the bitcoin price. The more people hoard up bitcoin (*higher BDD and lower bitcoin velocity*) and not spend it, the lower the price would go, as *BDD* has the highest relational strength. These relations could help as a model, to understand the deflationary and inflationary claims for bitcoin though one year of data is certainly very low for any universal claims. How this compares with standard price models, is again not conclusive at this moment due to extremely limited data suitable for comparison. However, it can broadly be seen that the bitcoin price can stand independent of other fiat currencies (*according to this model*) on its own merit. This is seen as contrary to certain Austrian Economics expert views (*Section 3.2*), that bitcoin only has value when pegged to a fiat currency.

Further, Venture Capitalist (*VC*) Chris Dixon¹⁴¹ suggested, that the price of a bitcoin could easily go upto \$100,000 in the future. The relation between bitcoin price rise and the subsequent price rise of goods and services (*inflation*) or price fall (*deflation*) needs further examination as explained earlier.

As an analogy, is the domain names for the internet, now priced upto \$10 million which would have been an absurdity to conclude in the 1990s. *VC* Chris Dixon, further stated that the major reason for the Bitcoin success is technology breakthrough along with having liberal politics on its side. However, not everyone is truly convinced. Peter Schiff¹⁴² (*Euro Pacific Precious Metals*) is a well known gold proponent and bitcoin hater in the community. He recently partnered with Bitpay (*leading digital wallet and exchange service*) to allow bitcoin owner's to own gold. He still believes a bubble is there and wants to offer an exit profitably.

Also, an interesting point of questioning, is the unit of account function of bitcoin. Traditionally, a money source is required to be a unit of account, store of value and medium of exchange. The unit of account feature and medium of exchange feature is seen empirically through the rising transactions and market price (*Graphs in the List of Figures at the end*). The transaction history of bitcoin could make different bitcoins unique, due to the inherent risk of blacklisting and money laundering legal issues. By this logic, popular digital wallet companies storing bitcoins like Coinbase would have the safest bitcoins due to possible resources invested in securing compliance from all regulations and having the highest safety standards. This change is bound to be more escalated in future with crime threats and regulation (Möser et al., 2013). In addition, taxing bitcoins as a property also destroys its fungibility¹⁴³ as its trace, price and expenditure differ making each bitcoin unique. How this evolves remains to be seen as by software, each bitcoin is just the same.

¹⁴¹ Silicon Valley VC Thinks a Single Bitcoin Will Be Worth \$100,000
<http://www.wired.com/wiredenterprise/2014/01/chrisdixon/>

¹⁴² Bitcoin hater Schiff now selling gold for bitcoins
<http://www.cnbc.com/id/101693790>

¹⁴³ How Israel Can, and Should, Become Ground Zero for Bitcoin
<http://www.coindesk.com/israel-can-become-ground-zero-bitcoin/>

Finally, it is seen that the major principles or rules of fiscal decentralization (UNDP, 1999) found in the literature of the UNDP match up with bitcoins broadly. The status of UNDP literature is mentioned along with correlation of the bitcoin ecosystem in *italics*. A major reason for conducting this, is to analyze how close or far bitcoin is as a system to promote financial decentralization, outside utopian expectations, as it also allows extremely centralized private players to exist.

The rules highlighted are:

- Independent expenditure priority (*a bitcoin foundation exists as an NGO to judge independently any expenditures the bitcoin network might need for sustenance*)
- Able to independently meet their own financial needs without needing government support. (*again, the bitcoin foundation NGO exists with representations across citizen groups to the business groups*)
- Tax collection in line (*This remains exploratory as governments are figuring out ways to collect tax on the network which is detailed earlier. For systemic functioning with rules of law applicable, a technically feasible solution would be possible*)
- Possible revenue organization and predictability (*the Bitcoin Foundations efforts and revenue are subjected to laws and public releases which can be judged on performance and predictability*)
- Efficient revenue allocation (*this is left to the discretion of the various members on the network and the bitcoin foundation to maintain the system*)
- Proper incentives in line to make system work (*these exist for the miners as bitcoin systemic tip and transaction fees to maintain the system*)
- Certain internal monitoring system for accountability (*internal monitoring is entirely due to being an open source community along with the Foundation nature. Also, the government can always request data from the private players or the foundation participating in the network*)

The next section details bitcoin's position with regard to the branch of Austrian Economics.

3.2 Austrian Economics

This section explores the parallel of bitcoin with Austrian economics. In *Denationalization of Money*¹⁴⁴ (1976), Austrian Economist F.A Hayek questioned why a government monopoly is considered indispensable for providing the money supply. This was written in the 1970s, a good two decades before Satoshi Nakamoto's paper on Bitcoin (2008), which could provide a practical solution offering to take a piece of his philosophy and put it to test. This section provides viewpoints of bitcoin from the Austrian Economics perspective.

¹⁴⁴ Why a State Monopoly on Money is Always Bad

https://www.cryptocoinsnews.com/state-monopoly-on-money-always-bad/?utm_source=rss&utm_medium=rss&utm_campaign=state-monopoly-on-money-always-bad

The idea of Private Money, Free Banks and Full Reserve Banking were central ideas that have some relation to the bitcoin ecosystem. As defined, 'Private Money' were seen to be issued by private parties subject to similar laws of private corporations which would compete on market share. As hypothesized, free banks would be places where private corporations would issue 'paper notes', similar to fiat currencies, without any backing on commodities like gold and silver while always competing with each other. In the free banks, the luxury of deposit insurance and lender of last resort as a government organization is absent. The irony as mentioned, is that the Free Bank experiments that came to be empirically practiced, had either fiat currencies (*US Dollar, Euro etc.*) or commodities like Gold and Silver as a full reserve and issued their own private paper money. This was in contrast to what Hayek had imagined in order to outgrow the requirement of a reserve. Also, maybe bitcoin as a system without any reserve of commodities or fiat currencies or any federal insurance or lender of last resort status, would be close to the functioning of free banks; though it is not privately owned. Theoretically, the other digital currencies are always giving competition to bitcoin.

Post, the Great Depression (1929), four major advantages of full reserve banking were suggested as these new ideas were proposed as a solution for the crisis. Popularly, it was referred as the Chicago Plan (Kumhof & Benes, 2012).

- A better control of business cycles, by preventing banks from creating credit on their own will, during the booms and then destroying them during the busts.
- A 100% reserve eliminates banks runs, as loans are always backed by 100% deposits. Thus, in case there is unprecedented panic, people can withdraw all their deposits without worry.
- A reduction in government debt to zero, as there is no borrowing of currency from central banks to manage the interest rate and money supply.
- As a positive side effect, private debts would also decrease as governments could always buy back private debts.

However, there were strong assumptions to the model like homogenous debt levels of banks which is idealistic. Also, there was no detailing of systemic risks, and the limitation of credit, this system creates (*due to the requirement of loans being 100% backed by reserves*), which contracts the economy.

Currently as reported, upto 4000 unofficial private¹⁴⁵ currencies are operating in the world. The most common being frequent flyer miles issued by airlines which can also be bought through fiat currencies. Also, experimentations were done with currencies like the 'Terra' which is a private currency to be backed by both fiat currencies and commodities with the caveat of being completely electronic and charging transaction fee for maintenance. This system would function with a 100% reserve banking model which implied that all the Terra currency issued was 100% backed by the market value of the deposits of commodities or fiat currencies. Also, no loans could be given out based on extra available deposits at any time, which is a feature of full reserve banking. However, as visible, this system resembles bitcoin without any reserve or centralized functioning. Also, it has not scaled as a private currency.

¹⁴⁵ Rethinking Money: The Rise Of Hayek's Private Competing Currencies:

<http://www.forbes.com/sites/peterferrara/2013/03/01/rethinking-money-the-rise-of-hayeks-private-competing-currencies/>

As a contemporary, Peter Surda has been a vocal supporter of bitcoin through his economics master thesis (*University of Vienna*) (Surda, 2011) followed by a research paper. It was stated that Bitcoin follows Austrian Economics as aggregate demand of goods and services could not be impacted (*through monetary policy*) due to the money supply being driven algorithmically. However the issue of intrinsic value was seen counter to Ludwig Von Mises Regression Theorem, which is one of the major foundations of Austrian Economics. As published in his seminal work of '*The Theory of Money and Credit*' in 1912 and reviewed by J.M Keynes in 1914 (Keynes, 1914), it takes the journey of a potential money source starting from a commodity having intrinsic value to a liquid medium of exchange and finally to a money source.

Peter Surda compromised the issue initially, stating that the successful level of transaction rates (see *List of Figures at the end*) have already taken it to a liquid medium hence the issue is bypassed. It was taken to a more convincing argument in his following paper.

Here (Surda, 2014), explained that society will always prefer a more universal and general medium of money if possible. A parallel of the IP (*Internet Protocol*) was given as the IP4 version which powers four billion plus website addresses, has no inherent value as this could increase transaction costs. A major focus was put on reducing transaction costs rather than having theoretical inherent value prior to use. The inherent value of the Internet Protocol, is stated in its ability to provide the technical infrastructure to allow these transactions to flow just like Bitcoin would allow the transfer of physical goods and assets on its network while being used as a currency too. Open source protocols like Colored Coins are exploring this possibility (*further detailed in Section 2.3.1 Technical Challenges*). This is similar to the argument given by the Venture Capitalist Andreessen Horowitz as stated in an earlier section. Further, Peter Surda gave an interesting pointer, that the idea of money must have come from some previous experience which might not be measurable as a commodity. Historically, commodities gain price and become a medium of exchange. This is the path of bitcoin with the duality of being a commodity and a currency.

This could also be seen through the growth in bitcoin over the years in a market driven mechanism. As seen, it took bitcoin about 10 months to build confidence as the first posted price of bitcoin appeared on October 5, 2009 where \$1 equaled 1,309.03 Bitcoin¹⁴⁶. Henceforth, it took another 18 months before bitcoin reached parity with the U.S. dollar. This is essential to understand, in the context of Regression Theory where the pre-history of the money source is important. Bitcoin was not always a money with economic value. It was once a pure accounting unit attached to a ledger. This ledger offering a payment system, could be what Mises called 'use value'.

This has been supported by proponents who state that Bitcoin¹⁴⁷ is both a payment system and a currency. Similar argument for value, through the technical infrastructure of the payment system is given. There was acceptance with the confusion, as currently Credit Cards (*payment systems*) are different than Paypal (*web service for online payment*) which is different than the Euro (*currency*).

As a reality check, it is seen that the majority of Austrian Economists¹⁴⁸ are critical of Bitcoin and crypto currency. There was barely a mention of Bitcoin at the 2014 Austrian Economics Research Conference. Three negative articles about Bitcoin had appeared in the Mises Daily articles of the Austrian Economics Mises Institute over a year ago. The major thesis of the criticism lies in bitcoin's inability to abide by

¹⁴⁶ <http://www.austriancenter.com/2014/08/29/what-gave-bitcoin-its-value/#sthash.ZqqCj2T8.dpuf>

¹⁴⁷ What gave bitcoin its value?: <http://www.austriancenter.com/2014/08/29/what-gave-bitcoin-its-value/>

¹⁴⁸ Bitcoin and Austrian Economics: <https://bitcoinmagazine.com/articles/bitcoin-austrian-economics-1409113330>

Regression Theorem completely. The limitation of Bitcoin¹⁴⁹ was stated, that it can function only as long as individuals know that they can convert it into fiat money, i.e. cash on demand. The idea of bitcoin being an innovative transaction medium was supported, but not without a frame of reference money having intrinsic value. Its price rise, it was explained is an indication of bitcoin services being valued and not validation for its usage as a currency.

Finally, in the modern day world even corporations themselves are seen to be becoming like governments¹⁵⁰ requiring similar efforts for regulating mal practices and dealing with how much freedom to give to their users. For example, it is seen that popular networking website Facebook started as an oligarchy governed by its founders. Further, it liberalized the economy by going public through shares, creating applications on its network and giving users different level of power. Hence, a new online service like bitcoin without any regulation seems, a bit far reached. Also, though bitcoin is optimized for online transactions, currently the online retail is still a very small part of all retail transactions. This also questions the claim of enabling transactions giving bitcoin its inherent value (Lo & Wang, 2014). The next section explores bitcoin's parallel with Keynesian Economics.

3.3 Keynesian Economics

In this section, the ideas of Keynesian economics will be explored, in its parallel's with bitcoin. The philosophy of British Economist John Maynard Keynes broadly supported demand side management (*of the goods and services*) through selective monetary and fiscal policy action of governments rather than waiting for the economy to recover on its own after a slowdown. It was suggested, that the supply of money should be held by the authorities for practical money management and its function as a store of value (Tily, 2012). This section mainly presents the Keynesian arguments for and against bitcoin.

By design, the money supply of bitcoin is algorithmically fixed which goes against the fundamental tenets of Keynesian economics, by negating government intervention in times of crisis or otherwise, through monetary policy of printing money. As bitcoin arrived after the financial crisis of 2007, there was a popular sentiment to support systems where entities do not misuse power to create lobbies. Ironically, Keynesian economics gained traction after the great depression of 1930s¹⁵¹, where according to the proponents, the government printing more money and using better fiscal policies to boost the economy, would have been better damage control than waiting for it recover automatically.

Also, historically it is true that hoarding of currency and limitations of spending due to fear of war, food scarcity or corrupted institutions can cripple the money supply. By theory, wages and prices also fall due to the shrinking of economy. In such circumstances, with unemployment and falling production rates, optimistic support from the government should always be given by printing more money and practicing suitable fiscal or tax policies through possible subsidies. Argued as the 'paradox of thrift', by J.M Keynes, the government has to usher in the good news to restore confidence again. For the banking sector, if the borrowers cannot repay loans or the depositors collectively withdraw their money too fast, the bank will fall short of funds causing a run on the banks. As a lender of last resort, the government always exists or in the case of bitcoins, as is argued; it is systematically rooted out. This is hypothesized to cause many banking panics in future.

¹⁴⁹ The Bitcoin Money Myth: <https://mises.org/library/bitcoin-money-myth>

¹⁵⁰ Web services as governments: <http://www.usv.com/posts/web-services-as-governments>

¹⁵¹ Bitcoin a Fool's Gold Standard: <http://dealbook.nytimes.com/2014/01/22/bitcoin-a-fools-gold-standard/?rref=collection%2Ftimestopic%2FKeynes%2C%20John%20Maynard>

J.M Keynes had also argued against the gold standard in the futility of spending enormous resources to extract gold from the mines and then keeping them stagnant in gold vault's, like the Federal Reserve banks of the US keep in Fort Knox. Printing trusted paper currencies propounds near zero marginal costs which could in principle be achieved by the government printing fiat currencies with the press. The gold standard and full reserve banking was dubbed as a 'barbarous relic' by Keynes in 'A Tract on Monetary Reform', while suggesting the possibility of maintaining stability of businesses, prices and employment outside of it.

The two properties of money suggested, were a means of exchange and a store of value. In his theory of 'Liquidity Preference' (Tily, 2012), it was suggested that savings should be held in a liquid medium. Also, it was suggested, that the rate of interest charged, is determined by the supply and demand for assets in which savings are put (*liquid money mediums*) rather the actual demand and supply of the savings. The major reward for holding money is essentially its liquidity and ability to be easily transferred into assets. To fulfill the store of value function (*along with being a medium of liquid exchange*), was important as Gold inherently had value and pieces of paper did not. The paradox was resolved through his 'General Theory' where the necessary condition for liquid holdings is an inherent 'uncertainty' regarding the interest rate charged and accrued on money. This means that economic activity, is at least partially dictated by human desire and sentiments (Bibow, 2005). This could, in theory, also motivate households, in keeping money instead of assets as a store of value.

However, the new age 'digital gold' of bitcoin (*according to Paul Krugman*), cannot even offer that luxury of having any value apart from 0's and 1's (*due to lacking any reserve or having inherent value or lender of last resort features of fiat currencies*). This handicaps the system, of being able to practice either fractional reserve or full reserve banking. The bitcoin mining requiring sizeable electricity and computing resources, is also questioned on the same logic of gold mining, being extensive on resources for no value addition. For example, the Porgera open-pit gold mine in Papua New Guinea¹⁵², is one of the world's top producers. Historically, gold mining has been related to tremendous human rights abuses. Similarly, as stated, the Bitcoin mine in Reykjanesbaer, Iceland uses a lot of electricity and lets out harmful emissions for no value addition. Iceland, with its cheap electricity from hydropower and cold air to cool the emissions, offers the same fertile ground which developing countries of Africa offer to gold mining, through cheap labor and resource abundance.

Also, Keynes supported the idea of Central Clearing Houses and a union for managing their affairs. These would be in place, to manage any systemic risks and support interbank lending among other features in times of crisis. He was of the opinion, that local capital controls are essential to manage regional economic and political situations. This is seen in contrast to a global no control system, where capital can move freely anywhere to reach global equilibrium interest rates. However, bitcoin by definition does not have any third party intervention in day to day affairs, though it does have a Bitcoin Foundation (NGO) to manage crisis situations (*See Chapter 6*) and move consensus towards systemic welfare. Also, the bitcoin ecosystem lets people move capital freely across borders with a button click. Local capital controls are currently absent at the systemic level, though they could be implemented in theory by any business offering trading facilities under the rule of law. This is a major reason for the ban of bitcoin in China (*See Section 2.4*). The next section addresses issues regarding the two main theories of Keynesian and Austrian Economics.

¹⁵² Bits and Barbarism: <http://www.nytimes.com/2013/12/23/opinion/krugman-bits-and-barbarism.html?rref=collection%2Ftimestopic%2FKeynes%2C%20John%20Maynard>

3.4 Addressing Issues

It has been observed that bitcoin mining is leading to competitive losses as a whole for the ecosystem. This could be attributed to the human nature of being extremely competitive as well as equilibrium issues of centralized/decentralized mining (Szczepański, 2014). Also, it could be attributed to early days interest in bitcoin mining, where many hobbyists have entered in order to extract some risk free profit. The metrics for comparing printing of currency and operation through fractional reserve banking (*with all the peripheral organizations*) compared to bitcoin mining per unit of value, is currently absent for an empirical judgment.

Hopefully, through various versions of competing digital currencies with variation in mining techniques, money supply and computing power (*detailed in Chapter 2*), the most energy efficient model could be tweaked and adapted for bitcoin after experimentation.

The idea of free banks has been criticized theoretically, for not allowing clearing houses to be present for managing systemic risks. Hence, completely free banks without regulatory oversight are not advised (Adhion, Bolton, & Dewatripont, 1999). Also, in a full reserve ratio bank (*as advised by Austrian Economists*), the relationship between the central government and banking authority is tenuous with private banks not being able to achieve higher levels of private profit and expansion of credit. With regard to bitcoin, there is an active Bitcoin Foundation whose role is to look into systemic maintenance and crisis situations. Also, there is no reserve in bitcoin currently and decisions on money supply are algorithmically driven. These factors can always be debated (*and changes implemented*) with little place for corruption in the Bitcoin Foundation, as all transactions are driven by consensus which is different from electing political representatives once every four/five years.

Also, Monetary Theory advocate Milton Friedman (Bibow, 2005) suggested removing monetary policy out of the hand of central bankers into an auto pilot organization. According to him, there should be no manipulation of interest rate policies by central banks (*according to Keynesian Policies*) as markets with sound money supply growth rate/contraction (*matched with business cycles*) would lead to good outcome. The major issue in complementing this idea to bitcoin (*as stated in Section 3.1*), is matching the bitcoin supply during the different business cycles, as the velocity of transactions (*which could balance lower/higher supply*) would be influenced by the control of consumers and not amendable by the Bitcoin Foundation. How these cycles are managed on reaching scale is an important question.

It is calculated by researchers¹⁵³, that 99% of bitcoin's possible 21 million coins will be mined by the year 2031. Henceforth, whether it is possible to practice fractional reserve or full reserve banking with bitcoin is an issue which has been debated. Theoretically, it is argued that just like banks, institutions could lend out loans¹⁵⁴ on holding some amount of bitcoins, to increase access to credit through practicing fractional reserve banking. As there is a fixed amount of money supply regardless of its eight digits of depth, this could be a way to counter deflationary spirals (*prices of goods and services*) getting out of control and regulating the money supply. However, the major issue for this seen from an Austrian economics perspective, is the need for debt instruments to be capable of being good money substitutes and lowering transaction costs like using paper currency (*near zero marginal cost*) for gold/silver coins (*higher marginal costs*). In the case of bitcoins, the development of a different debt instrument used in place of bitcoin, while bitcoin rests as a reserve, seems unlikely. The ability of this electronic debt

¹⁵³ Fear Not Deflation: <http://www.forbes.com/sites/jonmatonis/2012/12/23/fear-not-deflation/>

¹⁵⁴ https://en.bitcoin.it/wiki/Fractional_Reserve_Banking_and_Bitcoin

instrument to gain market traction on the bitcoin network by being unique, while appealing to its users, seems difficult.

Further, two types of deflations have been identified by the Asian Development Bank (Brooks & Quising, 2002). One positive and one negative.

- First Type (Positive): This is defined as a fall in prices which can result from technological innovation, increased productivity, decreased demand or a drop in prices of major hardware. This deflation is defined as positive as the prices of computing power dropping, has given more people access to goods and is benign.
- Second Type (Negative): However, deflation can also occur if people expect prices to continue dropping, or with rising unemployment and an environment of stagnated growth in the economy, particularly when public debt levels are high. In extreme cases, this can lead to the 'deflationary spiral' which is extremely harmful. In this case, as the depositors in the bank lose confidence in the economy, they can start withdrawing their deposits leading to further spiraling of the deflation cycle (*run on the banks*) and harming the solvency of the bank.

Bitcoin, due to its technical competency in reducing transaction costs to near zero and creating a decentralized asset transfer protocol, which is cheaper than through centralized institutions, could be the cause of the first type of deflation (*if and when it occurs*). However, if it leads to excessive hoarding (*lowering bitcoin velocity of transactions*) and pessimism on its inherent/unstable value, it could certainly lead to the second type of unfavorable deflation.

The only complete defense of deflation, has been found through Austrian Economists which has not been empirically verified to a satisfactory level. These are:

Firstly, former president of the Mises Institute, Mr. Doug French, explained in the essay, *In Defense of Deflation*, that contrary to popular theory, lower prices lead to increasing demand too (*First Type of deflation*). They do not reduce or delay it always or cause a panic. Hence, the electronics goods (*following exponential technology Moore's curve*) boom of Flat Screen TVs, cell phones, laptops etc. due their falling prices, opened up markets to lower income people. Mostly every society has more low-income people than high-income people, hence the effect is not necessarily negative.

Secondly, in *A Plea for (Mild) Deflation*, Mr. George Selgin expressed negativity for extreme demand-driven deflation (*Second Type of deflation*) as an unfortunate secondary effect of central bank inflationary monetary policy and defended benign deflation (*First Type of deflation*) as a result of increased productivity in systems. He further stated, that post the great depression of the 1930s, the fear of deflation has lead to an obsession with Keynesian Economics leading to six decades of inflation and forgetting about the good kind of mild deflation (*First Type of deflation*).

Thirdly, there is a paranoia of the 'Deflation Spiral Theory'¹⁵⁵ which has¹⁵⁶ been challenged empirically by bitcoin's short history till date, as at least three major deflationary periods have occurred. In mid-2011 (*the price ranged from around \$1 to \$30*), in early-to-mid-2013 (*from under \$20 to over \$200*), and most recently in late 2013 (*from around \$100 to over \$1,000*). These rising prices of bitcoin, lead to falling

¹⁵⁵ Deflationary Spirals: <http://web.mit.edu/krugman/www/spiral.html>

¹⁵⁶ Experience of Bitcoin Disproves Keynesian Deflation Theory: <https://spendabit.co/blog/bitcoin-disproves-keynesian-deflation-theory>

prices of the goods and services (*priced in bitcoin*). However, the currency has not been destroyed and as seen in the increasing adoption rates (*stated in the Introduction*) and seen in the increasing transaction rates (*List of Figures at the end*), there has been an increasing usage of bitcoins. While this is a limited empirical analysis and not enough to avert the importance of the potential crisis issues of deflation, it is an empirical observation.

As a conclusion, the major question of whether bitcoin fulfills the necessary criteria for a successful money system has been attempted in this chapter. This could be broadly stated as, a unit of account of account, medium of exchange and store of value function. Mainstream experts from both Austrian and Keynesian Economics are critical of bitcoin in being able fulfill this function as the medium lacks any inherent value and successfully reducing transaction costs, is a necessary however not a sufficient condition. An econometric model has been cited, suggesting the possibility of its independent existence outside fiat currencies, though one year of data has limited reliability. Overall, it is observed that the only possible parallel to bitcoin could be seen through the success of the internet in the information dimension, where legal public and private organizations exist. This was mostly denied by experts from around the table, initially. In being able to offer an efficient and regulated platform for value to flow, through asset ownership transfer of physical goods among other standard functions of a currency, bitcoin could evolve the traditional requirements of a successful money system. The next chapter details an 'Ethical Impact Assessment' to understand bitcoin's position on important values.

Chapter 4: Ethical Impact of Bitcoin

This section proposes to look at the bitcoin ecosystem from an ethical point of view. As the earlier sections were devoted to understanding its technical, economic and political challenges; this section explores its ethical challenges. Hence, in this chapter, two ethical frameworks from the literature in the ethics of technology, will be utilized. These are a 'large social experiment' traditionally by Martin & Shinzinger and an 'Ethical Impact Analysis' by Palm & Hansson. Further, the next chapter on 'Technology Decentralization' looks at understanding bitcoin as an appropriate technology for its environment. The focus in chapter 5, is on the traditional ideas of noted humanitarian M.K Gandhi and British economist E.F Schumacher along with modern ideas, to judge bitcoin's overall status. However, this chapter focuses on contemporary ethical frameworks, giving a balance of both world views.

4.1 The First Framework: Large Social Experiment

The first framework puts bitcoin in perspective as a large social experiment. It is seen, that bitcoin follows this analogy in being differentiated from an ordinary experiment (Wright, 2011). This is derived from the proposal originally put forward by Martin & Shinzinger in the 'Introduction to Engineering Ethics, 2000'. Recently it was applied by Van de Poel to nuclear energy (2011) and nanotechnology (2009). Further, an effort has been made to apply it to the information technology of bitcoin as suggested by Wright. Here (*taking place outside a laboratory setting*), the supposed unknown founder 'Satoshi Nakamoto' released an anonymous paper (*bitcoin genesis paper explaining the idea*) outside any academic journal on the internet, making the larger systems susceptible to possible mal use. As there was no official status of an experiment, it was subject to pure merit and market adoption. Hence, any deliberate monitoring and data gathering in the initial stages was absent. Also, being the first of its kind in the history of money systems, any major adoption would have irreversible impacts on the direction of economic systems.

Seen from this framework, any major societal experiment should have three factors aligned on its side. Firstly, a competent technology system which is managed soundly and verified for crisis situations. Secondly, it should be governed by democratic decision making processes. Thirdly, it should contribute to human and societal well being at a larger scale.

On the first perspective, a major innovation in bitcoin, is the lack of any third party approval for verification, which drastically reduces transaction costs and gives it a decentralized peer to peer nature, aiding in easy scaling up . This has major consequences for monitoring on a micro scale with the absence of any codified law in the bitcoin ecosystem. However, it is fair to say that there is a bitcoin foundation (NGO) which manages the day to day affairs of bitcoin and looks after contingencies. Also, businesses like trading houses, wallet services and mining companies run on the bitcoin layer that are governed by law.

Since the code and all transactions are inherently open source by nature, any major changes or issues can be reported to the open source community and implemented on reaching majority consensus. As explained in Chapter 2, bitcoin inherently functions with consensus and a 51% is needed to keep the transactions aligned with one version of the entire bitcoin transaction history which is available on every node (*connection*). Weather this 51% represents a majority view among the well informed or true democracy is again debatable, since the representatives of the bitcoin foundation are not popularly elected (*further detailed in Chapter 6*). Protocols for deliberately reaching out to every person either by

the bitcoin foundation or otherwise, have not been laid out. Only a 51% consensus is expected to keep the flow of transactions. Major hijacks by mal intentioned organizations can be possibly contained through collective actions by the governance coalitions (*as explained in Chapter 6*).

Secondly, bitcoin would get the advantage in being governed as a democratic open source system where the community could suggest any changes (*outside proprietary controls*) which could be implemented in principle by the foundation on majority consensus. The benefits to society from this experiment have been highlighted throughout the thesis, by reduced transaction costs for remittances, making access to banking as easy as the internet or email and finally a framework for decentralized and cheaper transfer of physical asset ownership through peer to peer mechanisms. Whether bitcoin is approved by democratic legal bodies, is certainly a question mark as highlighted in Chapter 2, where most nations have given limited clarification on its status and very few have deemed it illegal.

Thirdly, on being managed properly, bitcoin as a system could contribute to the benefit of society at large, as highlighted through advantages in the previous point. A major issue however, is of national security and terrorist financing, which has been highlighted earlier as an unjust side effect of innovation. However, this issue has been attempted in Chapter 6 through organizing governance coalitions in response to crisis situations. Finally, the issue of whether there is a fair distribution of hazards across users would be a positive for bitcoin, as it is a decentralized system with spread out points of failures rather than one central fragile one. The next section lists out an ethical impact assessment of bitcoin.

4.2 The Second Framework: Ethical Impact Assessment

Through research by (Palm & Hansson, 2006) eight relevant values/factors for an ethical impact assessment were recognized. In all fairness, this was meant to be given to the major stakeholders (*as recognized in Chapter 6*) and aggregately calculated. However, due to lack of credible access, this section will detail these different factors as explored from various resources in this thesis.

Dissemination and Use of Information

The dissemination and access to financial services with the open source nature of the algorithm is certainly a plus for the bitcoin ecosystem. Any individual with access to the internet can get access to financial services like a bank account (*digital wallet*) and remittance transfers globally. Efforts through startups exist to make operations as easy as emailing. Currently, major internet corporations like Facebook and Google¹⁵⁷ are trying to get the four billion people (*outside the internet zone*) access to free internet through drones and satellites. This would certainly help more people get access to financial services. Currently, Facebook's Internet.org boasts of getting large number of people¹⁵⁸ access to limited free internet services. This has come under extreme pressure from net neutrality activists, who suggest a strong business lobby in selecting the 'right' programs to be given to the people for free, rather than the entire internet experience. Academic reference for the exact number of people connected, have not been found.

¹⁵⁷ The internet space race is on: Google Loon vs Facebook drones vs SpaceX satellites: <http://www.pocket-lint.com/news/131699-the-internet-space-race-is-on-google-loon-vs-facebook-drones-vs-spacex-satellites>

¹⁵⁸ One year on, Internet.org gives a billion people internet access: <http://betanews.com/2015/07/27/one-year-on-internet-org-gives-a-billion-people-internet-access/>

Control, Influence and Power

Certainly, the power structures would be impacted if services like bitcoin gain mainstream adoption. The influence of central banks and governments over monetary policy, could be impacted during times of crisis. Possible ways to address such crisis situations is carried out in Chapter 6. The influence and power of a common person in being able to impact issues of national importance would be escalated as control over financial resources becomes more decentralized. As stated earlier, majority consensus is important to be able to move critical decisions, be it political or financial through bitcoin. Here, through the open source community, more diversity on the decision making table, would be a positive impact.

Impact on social contact patterns

As a major negative, it could be said that if banking as an institution becomes automated and decentralized, the level of human to human interaction would suffer. The experience of going to a bank teller and interacting with third parties for ratifying transactions is systemically rooted out through transcending the requirement of third parties in a peer to peer network. However, with increased peer to peer interactions and open source nature, meetups could be organized on severe problems being observed.

Privacy

The issue of privacy has been discussed in Chapter 2, 3 and 6 from multiple points of view. Broadly, weather societal freedom is enhanced and individual information protected, is essential to analyze. Through the public bitcoin addresses, it is possible to trace all the transactions that were ever interacted on the bitcoin network. However, the difference between the bitcoin address and personal details remains as tenuous as an email address and physical address with a caveat. People using the services of private wallet's or trading houses always provide personal details through KYC (*Know your customer*) requirements which are protected by law. Encroachment upon this information through technology hacking is certainly a risk.

Sustainability

The issue of whether bitcoin is sustainable for its energy consumption has been cited earlier due to statistics about excessive usage of electricity in bitcoin mining. This has been countered due to initial requirements of a decentralized system which gets more efficient on acquiring enough scale through network effects. The metric/data of comparing sustainability like Carbon footprint of bitcoin versus fractional reserve banking (*with all its peripheral organizations*) is lacking currently.

Human reproduction

This section is not of much concern for bitcoin with more relevance for biotechnology driven services.

Gender, Minorities and Justice

Weather bitcoin promotes access of financial services to minorities and hence justice in the larger sense, is an important issue. As it currently stands, access to banking is contingent upon national regulations, minimum balances and policies of individual banks with about two billion adults globally without access to banking services. This is surely related to poverty in general. However the marginal cost of getting banking services on an individual level, drastically reduces to having an internet connection which as explained earlier is being endeavored as universally free. Also, the gender gap between males and females on access to banking services is currently 65% men to 37% women¹⁵⁹ which has cultural and economical reasons. This could certainly be impacted through the bitcoin ecosystem. A major issue of intergenerational justice does arrive with bitcoin, as a major hack on the system could impact the fortunes of the coming generation due to reducing the power of third party intervention in transactions. This as a concern is dealt with chapter 6 through essentially supporting governance coalitions.

International Relations

How bitcoin impacts the diplomatic relations between nations and institutions is extremely important as control over money supply has been a fundamental aspect of every modern nation state. Whether this leads to stabilizing or destabilizing international relations is an important concern. Certainly, any monetary transaction over the bitcoin network would be governed by adapted international laws sooner than later. Hopefully, this could improve international relations as extensive acts of warfare by democratic nations would need moment to moment consensus approval, rather than being the sole discretion of appointed leaders. Also, the ability to support extremist terrorist financing could be a major issue in destabilizing international relations as it was conjectured, that the recent attacks on Paris were financed through bitcoins¹⁶⁰. A major reason for this is bitcoin being difficult to trace by authorities (*when masked by technical professionals on the internet*) and easy to transfer globally without currently strong currently controls through international laws.

4.3 Recommendations for the Impact Assessment

As can be observed, in this ethical framework three factors seem to positively lean towards bitcoin, while two factors are against and two being ambivalent conditional on circumstances. The major recommendations would be, to try and make changes to the ecosystem to move all the factors in favor of bitcoin. For this, certain systemic actions can be recommended.

Factors positively impacted by bitcoin:

Dissemination and Use of Information

Control, Influence and power

Gender, minorities and Justice

¹⁵⁹ Two billion adults still 'have no access to banking': <http://www.bbc.com/news/business-32314901>

¹⁶⁰ European Union to Crack Down on Bitcoin After Paris Attacks: <http://www.coindesk.com/european-union-to-crack-down-on-bitcoin-after-paris-attacks/>

Factors negatively impacted by bitcoin:

Impact on social contact patterns

Privacy

It could be argued that bitcoins through its technology driven interphase, will accentuate social isolation reducing human to human interactions. However, it would be theoretically possible to organize more physical meetup events for increasing networking and funding causes, due to reduced transaction costs which could undo some negative impacts.

Also, the issue of privacy has a precedent of the internet, which in its bid to make a more open world through social networks and online data sharing, has made certain sections of the non-technology savvy population more vulnerable. Through making data more open and available, a sense of nobility and ease of access has been attributed. However, as suggested by the French philosopher Michel Foucault, these methods of 'universal gaze' or access, create means of subtle power control. As seen in management theory, by giving people more information technology access, their behavior and expectations can be better 'managed' or 'controlled'. Further, this would encourage the people being observed, to maintain 'pleasing' personalities which could classify as a subtler form of control (Introna, 1997). It is conjectured by Venture Capitalist Fred Wilson¹⁶¹, that startups built on bitcoin using blockchain distributed open source database technology, might actually give users more power over their own data, rather than relying on privately held corporations like Facebook and Google which could misuse them. In that sense, Bitcoin could undo some of the damages to privacy by individualizing ownership over personal data.

Factors ambivalently influenced by Bitcoin

Sustainability

International Relations

The issue of electricity consumption of bitcoin mining could certainly be impacted by experimenting and learning with multiple competing digital currencies, with different constraints. The improvements could always be made to any digital currency as long as it is open source like bitcoin. For example, apart from efficiency improvements in technology, adaptations could be made to reduce the number of people competing for mining rewards and hence using computing resources and electricity. This could include a limit to the number of computer units which could theoretically compete per transaction on mining for a particular bitcoin or ratifying a transaction. This would reduce systemic emissions and could be dynamically based on overall electricity consumption. It would be appropriate to emphasize that the competition set up in bitcoin, is not arbitrary and meant to incentivize the majority of miners to follow consensus rules for attaining mining rewards and offering lowest transaction fees.

Also, the issue of national security and terrorist financing is grave for stable international relations. This could be impacted by considering the suggestion of governance coalitions (*Chapter 6*) more seriously. As the major stakeholders involved in bitcoin are more diverse than the ruling government from miners to

¹⁶¹ Fred Wilson makes eerie prediction that blockchain technology will do more than just create the next Google:
<http://www.bizjournals.com/newyork/news/2015/10/19/fred-wilson-makes-eerie-prediction-that-blockchain.html>

citizen activist groups and the bitcoin foundation; a diverse governance coalition will help take better action and reach consensus on the best dealings with extremist threats.

Finally, this chapter attempted to answer the broader ethical impacts of bitcoin on society, while offering possible improvements. It is seen that there are more factors influencing bitcoin negatively/ambivalently than in a positive way in a ratio of 4:3. This is based on individual values, hence it cannot be quantitatively analyzed to a large degree. Mostly, the issue of privacy, sustainability and stable international relations are grave to consider and worked upon. Further, as a large social experiment, bitcoin could have irreversible impacts on society, due to its novel nature. Hence, it must be governed in a democratic manner with strong emphasis on human well being. The democratic angle has been questioned, due to the de facto Bitcoin Foundation which is not popularly elected, though the majority consensus and open source code, does guarantee some democracy. This issue has been further explored (*in Section 6.2.5 Crisis 5: Power abuse by the Bitcoin Foundation*) and successfully resolved. The next chapter deals with the idea of 'Technology Decentralization' and bitcoin's role in possibly promoting it, according to a traditional world view of appropriate technologies and a selective modern view.

Chapter 5: Technology Decentralization

The choice of studying and exploring decentralization of technology is purely a value judgment which can never be given as a universal solution. Whether, standalone centralized or decentralized systems are better for society or a combination, has been debatable. As stated earlier, the United Nations Development Programme (UNDP) (*detailed in 2.3.1 Technical Challenges*) has always preferred a combination of decentralization and centralization, which has been found in bitcoin. The metrics for judging the extent of decentralization, have been explored through selective theory. Further, the two sections, study the theory of a traditional appropriate technology and bitcoin's status with regard to it and modern technologies. The interest lies in understanding whether the classical tenants are still applicable to bitcoin and if it is possible to suggest changes to these criteria's.

5.1 Traditional Appropriate Technology

Do advanced technologies provide for a world view of more balance and harmony? Such questions will be explored in this section through the book, 'Small is Beautiful' by British Economist, Dr. E.F. Schumacher along with ideas of humanitarian M.K Gandhi.

Dr. E.F. Schumacher, as a protégé of J.M Keynes (*Keynesian Economics*), had an interesting oversight of how his mentor saw the world. Keynes disagreed with the idea, that financial equilibrium was around the corner and all systems reach there in the long run. He had stated, "in the long run we are all dead". Hence government action to support struggling economies must be taken in the present, rather than waiting for the future. Further, according to Keynes, idealistic virtues of equality and balance must be compromised a little longer, till the desired level of growth is achieved. This, according to the author lacks permanence and falters from the same illusion it tried to defeat initially, regarding waiting for the long run financial equilibrium (Schumacher, 1973).

The book ends with the claim, that Science and Technology is inherently valueless and sages/thinkers throughout time have challenged materialism and maybe it is our time to play that role again. It is stated with regret, that 'Scientific Materialism' seems to be suffering from the same universalism issue that Marxism (*class struggle*) and Freudian thought (*psychological neurosis*) has historically suffered from. These world views ignore the non-material/spiritual aspect of life. A rule of thumb is given that countries with most advanced technologies, have least the leisure time for the majority population.

It is questioned by Schumacher, that if the purpose of Industrial Revolution was to free man from mundane labor, with more advanced technologies; this promise has not stood the test of time. Most workers feel alienated from their work due to excessive materialism and statistics of (*Gross National Product*) GNP etc. do not measure the human condition entirely. Hence, an idea of 'Buddhist Economics' is given, where small scale decentralized technologies with cultural diversity are adopted, with the purpose of advancing time for creative pursuits. These are seen as 'Appropriate Technologies', having a sharp contrast with modern advanced technologies causing mass migration to cities, massive unemployment and deeply unsatisfying lives. The need of the hour, as explained by the author is for a permanent meta economics with a spiritual space, than one of impermanence; be it of compromised virtues of Keynes or the wait for the illusive financial equilibrium.

Following Schumacher's suggestion, we may then look at M.K Gandhi, who is often cited as the father of the 'Appropriate Technology' movement, though the concept had not been given a name then. He advocated for village technologies and disagreed with an idea of technology, that benefited a minority

of people at the expense of the majority or one that put people out of work to increase minority profits (Akube, 2000).

For Gandhi (Mukherji, 2007), the idea of decentralized systems is based on non-violent groups settled in small communities or villages with voluntary cooperation and dignified existence. Transferring power to grassroots levels is essential, as centralization can only be sustained with adequate force. He was confident that if India is to evolve around non-violent lines, it will have to decentralize many things. Centralization, by definition is inconsistent with non-violence and moral progress of humans which he dubbed to be synonymous with the spiritual. The perfect democracy, he explained is based on individual freedom with the law of non-violence governing the small ecosystem with which the might of the world can be defended. In his political structure, there are many small interconnected ecosystems/villages but not ascending circles. This was done to keep the influence of the state in day to day matters, as limited as possible.

As for technologies, he was of the view that to sustain peaceful living, the individual ecosystems must take responsibility for day to day affairs from agriculture, finance, education, sanitation, healthcare etc. and seek to offer the 'higher levels of state' any possible learning's to function better. These must be localized technologies as advanced technologies create extreme centralized systems which change the trend from production by masses to mass production. Due to the mechanization of lives, he was of the opinion that advanced technologies by definition cannot support decentralization.

On the whole, the traditional idea of an appropriate technology seems idealistic, but reinforces the importance of not exporting essential ideals to an imaginary future, as has been thought in the past. The basic tenets are detailed and evaluated for bitcoin in the next section, along with modern day ideas of an exponential information technology and an open source system. Maybe, a correct framework for an overall appropriate technology would be the modern ethical frameworks (*stated in Chapter 4*) where a classical framework as suggested in this section exists along with space for selective new ideas, as mentioned in the next section.

5.2 Bitcoin Status

This section discusses basic ideas of a classical appropriate technology and bitcoin's observable applicability to it. Also, modern attributes common to bitcoin like exponential information technology and open source systems are explored to judge their fit, to an overall characteristic of a technology fit for current times.

5.2.1 Bitcoin Status: Traditional Appropriate Technology

Six main factors are seen to broadly contribute to Appropriate Technologies (Hazeltine & Bull,1999). These are:

- Small-Scale
- Decentralized
- Labor-Intensive
- Energy-Efficient
- Environmentally Sound
- Locally Controlled

Most of these factors with reference to bitcoin, have been collectively discussed in Chapter 4. Bitcoin could be seen to promote decentralization, energy efficiency while being environmentally sound and locally controlled. The positive factors of bitcoin like energy and environment efficiency would be seen to arrive with adequate scale and systemic changes, if needed. Certainly, bitcoin would not be seen as a labor intensive technology as the emphasis lies in creating efficient, cost reducing automation. Through a layer of networks which allow for both centralized and decentralized systems to exist; both small scale and large systems could flourish on the network.

Hence, in the traditional outlook of a technology promoting local social interactions and being small scale, with its predecessors (*rural solar, water harvesting, regional sanitation programs etc.*) bitcoin would seem as a misfit to a classical appropriate technology framework. On most materialistic factors, it would certainly seem as a positive.

The strict decentralization ideology of M.K Gandhi, is seen to be a misfit for bitcoin. Even though, it can promote decentralization of payment mechanisms and asset transfer, the village ecosystem environment is difficult to replicate, in its localized socially inclusive way. The major reasons, are due to the flexibility of the bitcoin ecosystem allowing for both centralized and decentralized players to exist. There is local peer to peer connection and a global outreach possible with bitcoin. Further, though it allows diverse financial activity to occur on the platform, the human to human interaction would probably suffer for both decentralized or centralized players (*due to ascending power circles*); which is an essential part of M.K Gandhi's ideology. This human connectedness helps in prospering moral progress, non-violence and social inclusion dubbed as spiritual, which is essential to balance materialism. This factor has been largely ignored in the bitcoin system design, as also observed in Chapter 4. Though, local social meetups (*promoting local culture*) could always be encouraged in the bitcoin ecosystem, it is not a necessary part of its design.

5.2.2 Bitcoin Status: Modern Technologies

Seen, from a modern day perspective of an open source and an exponential information technology; there are positives for bitcoin promoting technology decentralization, as is parallel to other domains. Their attributes are seen as essential to maybe evolve the traditional appropriate technology framework.

Interestingly, the world has been swiftly moving from hierarchies to networks¹⁶² in multiple domains, which could be seen as an aspect of improving decentralization. In news media, we are seeing a shift from traditional newspapers to Twitter online service where everyone can be a journalist. Entertainment is moving from record label industry/television to YouTube/Sound Cloud/Netflix giving people an opportunity to connect with users on merit, in a peer to peer decentralized and cheaper way, with lesser bureaucracy and content control. Funding for projects, movies and companies is moving from traditional financing by few resourceful individuals to crowd sourcing, where communities offer support. Education is moving from traditional top down schools to online education through sources like Khan Academy, Edx.org, Coursera.org etc. giving the learner, freedom to explore with accreditation on demand. In transportation systems, car sharing services like Zipcar and online cab aggregators like Uber are gaining exponential traction. Similarly, money as a decentralized system is being explored through

¹⁶² These are extracts taken from a lecture given by Mr. Fred Wilson, Managing Partner, Union Square Ventures: <https://www.youtube.com/watch?v=R43OKYmGbHU>

digital currencies like Bitcoin, relying on advanced technologies and open source ethics in an effort to complement centralized government backed currencies.

Further, enthusiastic proponents of such modern technologies have broadly come under the umbrella of embracing technological singularity which suffers from technology determinism. The term 'Technological Singularity'¹⁶³ has been referred as a technology utopia expected around 2045, when machine intelligence becomes a billion times more powerful than human biological intelligence. The metaphor of singularity has been borrowed from theoretical physics, where on crossing the event horizon in a cosmic black hole, the space-time models of physics break down and it is unknown, what happens next. Such rapid growth of technology is fundamentally based on the exponential cost efficient rise of information technology which takes help from Moore's Law¹⁶⁴. As the human brain is seen to be well versed with managing linear not exponential patterns and problems, such behavior is seen as inherently non-intuitive. These ideas have been popularized by Ray Kurzweil who is an American futurist, entrepreneur and technologist.

Ray Kurzweil¹⁶⁵, is currently the Director of Engineering at Google and dubbed the 'the restless genius' (*The Wall Street Journal*) and 'the ultimate thinking machine' (*Forbes magazine*). He has received over 20 honorary doctorates among many other awards, as he invented the first flatbed scanner, print to speech reading technology for the blind, among other inventions. He helped setting up a university in Silicon Valley (*California*) called Singularity University (SU) in 2011, on the idea that future exponential technologies of Information Technology, Nanotechnology and Biotechnology among others, will help to decentralize the world, while solving major issues like sanitation, poverty, energy etc. The university works under the motto of trying to impact a billion people with new technologies and solving real world problems. Through this, it is hoped that decision making itself will get more decentralized as more people are able to contribute to world affairs. Also, through technologies like personalized three dimensional printing for physical products, extremely small (*nano*) structures for cost effective medical deliveries and unmanned drone delivery services, it is believed that access to major resources in the world will increase through using the digital medium for transfer. This would improve decentralization, as ownership and production of goods would be more divided through improved mediums of digital transfer and peer to peer distribution systems.

Peter Diamandis, is also an American entrepreneur, founder of the X-Prize Foundation and Co-Founder/Executive Chairman at the SU. Here 6D's of exponential information technologies were developed as a framework which promotes decentralization. These were detailed in Peter Diamandis' recent book *Bold: How to Go Big, Create Wealth, and Impact the World* (Diamandis & Kotler, 2015). The 6D's were seen as attributes, historically common to the open source internet. It was suggested that Bitcoin is currently pitted to going from the '**deceptive**' (*point 2*) to the '**disruptive**' (*point 3*)¹⁶⁶ state in the next one to three years. In short, after being released anonymously as a digital currency, bitcoin was unknown to most people. Based on the pattern described below for exponential technologies, on improving user interphase and ease of use (*similar level to email*) bitcoin is expected to move from point

¹⁶³ Technological singularity: https://en.wikipedia.org/wiki/Technological_singularity

¹⁶⁴ Named after Intel Corporation Co-Founder Gordon Moore: "Moore's law" is the observation that, over the history of computing hardware, the number of transistors in a dense integrated circuit has doubled approximately every two years. Hence, computing power has increased exponentially and cost has reduced dramatically too.

¹⁶⁵ A brief carrier summary of Ray Kurzweil: <http://www.kurzweiltech.com/aboutray.html>

¹⁶⁶ Bitcoin: Going From Deceptive to Disruptive <http://www.forbes.com/sites/peterdiamandis/2014/06/23/my-insights-on-bitcoin-going-from-deceptive-to-disruptive/>

2 to point 3. This translates from being unknown, to gaining importance exponentially for providing marginally better services and disrupting specific industries.

These **six D's** with direct application to bitcoin are explained below.

- **Digitized:** Bitcoin is a purely digital global currency. Every bitcoin is traded, earned, sold, exchanged and bought in cyberspace. Hence, Moore's law of an exponential curve applies to it. In lame man terms, Moore's law is a metaphor dubbed for rising computing power of technology per unit of money. Here the same computing power exponentially increases, hence exponentially reducing in cost, resulting in first type positive deflation (*detailed in Section 3.4 Addressing Issues*). As bitcoin is purely digital binary code (*0 and 1*) it is bound to reap benefits of improving computing power and cost efficiency to serve more people in a better and cheaper manner with time.
- **Deceptive:** Bitcoin software was released to the public in 2009 and was seen to be growing in a deceptive phase even though few people had heard about it, few used it and fewer accepted it.
- **Disruptive:** When Bitcoin develops a good user interphase, its growth will be disruptive where its value, usage and rate of acceptance will show very positive trends. This is expected in the next one to three years.
- **Dematerializing:** Bitcoin is dematerializing the use of physical money (*bills and coins*) and even credit cards. Hence, there is a replacement of physical materials into digital code, with near zero marginal cost of distribution.
- **Demonetizing:** By lowering the cost of transactions, bitcoin makes it cheaper to share and spread money. Also, by default it targets the role of middlemen (*banks, lawyers and exchanges*), hence making the system on the whole more cost efficient.
- **Democratizing:** Bitcoin makes access to capital available to everyone with an internet connection. Places where no banks, no ATMs and no credit card suppliers exist, bitcoin can theoretically provide services as the technology companies like Facebook¹⁶⁷ are working to provide free internet services to major parts of the developing world. This idea of democracy aims to result in more people getting access to the specific resource and hence contributing to the decision making of its production, usage and distribution.

The only D not mentioned explicitly is decentralization, as it is expected to be a cumulative effect of the remaining factors for such technologies. In short, this definition of decentralization aims at getting more people access to goods (*through digital distribution methods, exponentially cost effective products and promoting peer to peer/personalized production*) and hence impacting the decision making of its control, production and distribution.

¹⁶⁷ Zuckerberg: 15M people worldwide can now access the Web via Internet.org:
<http://venturebeat.com/2015/10/28/zuckerberg-15m-people-worldwide-can-now-access-the-web-via-internet-org/>

Also, the open source¹⁶⁸ nature of these information technologies must be emphasized. The vision isn't to eradicate all private property but to make a layer of decentralized open source applications. These would be designed to support the basics of humanity. Further, advanced skills would be used for creating a medium for proprietary designs/products, as seen in the digital entertainment industry. A large amount of free content exists, with people paying for proprietary media through cinema halls and services like Netflix.

Currently, free and open source software projects¹⁶⁹ like status.net, diaspora project, friendio, buddy cloud and media goblin aim at returning control over data to the user's. These services keep data spread and decentralized across multiple locations. Ensuring communication between these locations is simple and transparent, which is the spirit of decentralization, rather than consolidating data in large data centers (storehouses). Though these services are not very popular currently, there is a positive trend. Interestingly, the open source Linux Foundation¹⁷⁰ is growing at an increasing annual rate from 150 to 290 companies and individual members from 6000 to 13,000 in early 2014.

In relevance to bitcoin (*as mentioned in Chapter 4*), it would be capable of moving the privately controlled and monitored data to the public blockchain, giving user's control over their own information. This would only be possible, as bitcoin is inherently open source and data can be stored in the blockchain (*database technology of bitcoin*) powering bitcoins. This would offer a systemic incentive for maintenance, provided through the value of the bitcoin currency. Private corporations like Facebook, Google, Apple etc. with access to user data, have been known to be under pressure and compromised from government surveillance systems like the US National Security Agency (NSA) Prism¹⁷¹ as well.

Hence, it is important to draw an overall understanding of whether bitcoin enhances decentralization appropriately or not. The answer mainly depends on the definition and understanding of decentralization. This chapter was initiated with traditional ideas of classical thinkers like Dr. M.F Schumacher and M.K Gandhi. They propounded a materially and spiritually balanced idea of localized decentralization. This was classically termed as an 'appropriate technology'. In modern times, the 6D framework as presented by the Singularity University, is a materially enhanced idea of decentralization. It is fair to say, that by design, bitcoin certainly promotes the 6D framework of decentralization and falls short in the spiritual aspect of a traditional decentralized system. This factor could be addressed independently by accentuating local meetups and local cultural bonds. However, this has not been currently cited as a major priority; as is expected by the traditional appropriate technology framework. Further, the ethical impact assessment in the previous chapter, probably presents a more balanced analysis, combining factors from both the world views. The next section explores regulatory coalitions for the governance of bitcoin.

¹⁶⁸ Ray Kurzweil on Singularity 1 on 1: Be Who You Would Like To Be: <https://www.singularityweblog.com/ray-kurzweil-on-singularity-1-on-1/>

¹⁶⁹ miscellaneous notes: a review of the print 3d printer <http://opensource.com/education/14/1/review-printbot-simple-bit>

¹⁷⁰ <http://opensource.com/law/14/2/top-10-legal-issues-2013>

¹⁷¹ NSA Prism program taps in to user data of Apple, Google and others: <http://www.theguardian.com/world/2013/jun/06/us-tech-giants-nsa-data>

Chapter 6: Regulatory Coalitions for Effective Governance

This chapter aims to create regulatory coalitions, which could be used for effective governance of the bitcoin ecosystem. Firstly, the idea of coalition formation is explained, which is followed by the different coalitions based on seven crisis situations. The payoff's which explain the power distribution in the coalitions are stated, with one game represented in complete characteristic form as an example.

6.1 Coalition Formation

This section was carried out in accordance with the idea that no rules can be imposed on the bitcoin network and must work through majority consensus (Kroll et al., 2013). Systems built on top of the bitcoin network, can always be regulated like the financial exchanges which are currently regulated as Money Service Businesses (MSB) (FinCEN, 2013). The behaviour of the network however, is open source in nature and decentralized in power structure. Countries like Japan¹⁷² have called for international collaboration on Bitcoin and start-ups like Cryptovoter¹⁷³ have emerged, which offer voting abilities on governance issues of bitcoin. The major issue with choosing an over analytical method requiring many assumptions, is that it is still early days for the network. However, the importance of governance has been understood through the thefts¹⁷⁴ and possibility for harming national security¹⁷⁵ interests (*through money laundering*) as money can be transferred as simply as emailing by anonymous agents. By definition, no one authority can dictate terms like a government issued authority, hence the major stakeholders need to come together in representation, to overlook governance issues.

The main regulatory solution offered in the thesis is using Game Theory to analyze stable coalitions of the major actors in cases of crisis. If a stable coalition with the relative powers of players (*highlighted through their payoffs*) could exist, then the coalition would not go back on its decision and help in smoother governance. These possible coalition members include the Bitcoin foundation, International Monetary Fund, miners, users, United Nations, independent think tanks, citizen activist organizations like think tanks and foundations, national governments etc. The power balance in situations of crisis, could help understand possible institutional design, as by definition if 51% people on the network disagree, major decisions can be overturned. The major reason for this, is because only one version of transaction history must exist on every link of bitcoin and a majority domination (*by rejecting or accepting transactions*) can change that. Hence, no parliamentary system of government vote (*elected every five odd years for example*) is in total control of this situation.

¹⁷² Japan Pushes for International Effort on Bitcoin Regulation

<http://www.coindesk.com/japan-pushes-international-effort-bitcoin-regulation/>

¹⁷³ A Solution To Bitcoin's Governance Problem: <http://techcrunch.com/2015/09/21/a-solution-to-bitcoins-governance-problem/>

¹⁷⁴ A history of bitcoin hacks: <http://www.theguardian.com/technology/2014/mar/18/history-of-bitcoin-hacks-alternative-currency>

¹⁷⁵ This difficulty of locating the actual person behind a particular IP due to the Tor network mixing IP's globally has been re-iterated by Richard B. Zabel, Deputy U.S. Attorney for the Southern District of New York during the NYDFS PUBLIC HEARING REGARDING VIRTUAL CURRENCIES January 28-29, 2014: <http://www.totalwebcasting.com/view/?id=nysdfs>

6.2 Testing Coalition

This section will test the different coalitions, according to possible crisis situations that could come up in the bitcoin ecosystem. A one size fits all solution is not presented. The major stakeholders for the different crisis situations could be broadly classified as:

1. National Government (*NG*)
2. Bitcoin Foundation (*BF*)
3. International Monetary Fund (*IMF*) as part of the United Nations (*UN*)
4. Miners (*M*)
5. Citizen Activist Groups (*CG*) including think tanks and foundations
6. Business Groups (*BG*)

6.2.1 Crisis 1: Taxation Collection and Acceptance Issue

A sudden increase in bitcoin acceptance, could impact the usual medium of people paying taxes through fiat currency. It is possible that the government might not accept its new role of collecting taxes on the bitcoin network, as they might not be able to force citizens to pay, requiring bidding for support on specific projects.

Bitcoin being inherently an open decentralized digital currency (*unlike others digital currencies like Ripple which is centralized for private maintenance*) cannot enforce taxation on its protocol, regardless of the technology sophistication. In case the popularity increases to a level where it is a leading currency (*like the reserve currency of the US dollar*) making sure taxation comes through, for the nation state sustenance would be possible through legal enforcement. This could include accessing citizen databases and requesting them to commit a certain amount of their income to taxation. Tracking their income and expenditures actively through the money system, would not be extremely productive as has been with fiat currencies, even though all transactions can be openly seen on the network. Also, a more popular solution might become active bidding by the government on specific projects, for support on the network through crowd funding techniques. This would place a national government in a similar space as foundations and private corporation, without monopoly advantage on income through legality and jurisprudence.

Hence, a mixed governance coalition would best serve in managing this dilemma. The members could be:

1. National Government (*NG*)
2. Bitcoin Foundation (*BF*)
3. Business Groups (*BG*)
4. Citizen Activist Groups (*CG*)

In principle, the national government with feedback from international bodies like the UN on legalities, could put pressure on the Bitcoin Foundation to give it de facto taxation power. Also, it could lobby Business Groups running on the bitcoin network, to find solutions to collect taxation. However, if these

solutions are not popular in public, the Bitcoin Foundation in principle could not enforce them. For example, a solution to put aside a part of every transaction for taxation purposes could be rejected, if a majority (51%) of the network members disagree and start a new fork (*history of transactions*) of bitcoin with majority support. Alternatively, citizen groups could lobby for the citizens to choose whether to pay taxes. It could be argued that the government should be competitive enough with other foundations (*supporting minorities/causes*) or businesses (*supporting innovation*) when asking for their money.

Currently, these issues are meaningless as governments can monitor the fiat currencies and make sure citizens regularly pay the gamut of taxes from entertainment, house, sales to income tax in legally appropriated amounts.

Finally, when all else fails, on legality terms to maintain a large nation state, the government could always move the legislature nationally and internationally, to create laws forcing citizens to pay certain amounts of money, regardless of the currency to maintain law and order. How this could be challenged in time, remains to be seen, as unpopular public laws become harder to pass leading to societal unrest. This had been the recommendation from OECD (*Organization for Economic Co-operation and Development*) (Blundell-wignall, 2014) to combat any danger from digital currencies like bitcoin.

Hence, a stable governance coalition would help in easing the situation and reaching consensus. In case, the National Government (NG) could work with the Citizen Activist Groups (CG) to understand citizen sentiment, while exploring technical solutions with the Bitcoin Foundation and Business Groups, more progress could be made. Hence, situations of legal enforcement or asking for money like Wikipedia regularly could be avoided. Interestingly, Wikipedia has been very successful in generating money on its website due to the impeccable service. It raised the target of \$16m in 50 days in 2010 and \$8.7m in 67 days in 2009, due to citizen belief in its valuable service.

Payoffs:

The payoffs are calculated on assumption, as data for these unprecedented events, is not possible to collect through interviews or analysis. Both the National Government and Citizen Activist Groups have been given a higher payoff (*though equal amount*) as they can lobby the legislature and citizens, through equal force and impact. The Bitcoin Foundation and Business groups have been given an equal (*but lower*) payoff as the ability to negotiate a technical solution (*by the foundation*) or shelving a part of their private profit (*by the businesses*) is subject to competition and survival.

1. National Government (NG) = 0.3

2. Bitcoin Foundation (BF) = 0.2

3. Business Groups (BG) = 0.2

4. Citizen Activist Groups (CG) = 0.3

Game:

Firstly, the game is converted to a characteristic function form (*with coalitions*) (Straffin, 1993) where different coalitions are formed and applied among the members. The different security levels (*payoff a member receives in the worst case scenario*) is considered to be the initial payoff. Also, the characteristic form function is assumed to be super additive. This means that the different payoffs of the members, when combined in a coalition, get added as a measure of their power to influence the course of events.

Also, keeping group rationality in place, when members come together in a coalition they should get at least as much as they were getting on their own, defined by their individual rationality. Hence, a payoff of 0.05 is added as a natural consequence of increased power in the game while working as a coalition.

TABLE 2: GAME IN CHARACTERISTIC FORM FOR CRISIS 1

$v(\text{NG}/\text{BF}) = 0.3 + 0.2 + 0.05 = 0.55$	$v(\text{BF}/\text{BG}) = 0.45$	$v(\text{BG}/\text{CG}) = 0.55$	$v(\text{CG}/\text{NG}) = 0.65$
$v(\text{NG}/\text{BG}) = 0.55$			$v(\text{BF}/\text{CG}) = 0.55$
$v(\text{NG}/\text{BF}/\text{BG}) = 0.75$		$v(\text{BF}/\text{BG}/\text{CG}) = 0.75$	$v(\text{BG}/\text{CG}/\text{NG}) = 0.85$
		$v(\text{CG}/\text{NG}/\text{BG}) = 0.85$	
$v(\text{NG}/\text{BF}/\text{BG}/\text{CG}) = 1$ (grand coalition)			

These coalitions represent all the possible combinations of the different members, keeping in mind their respective payoff's (*values*) and the property of super-additivity, where the payoff's are added. As a natural consequence, the grand coalition of all the members combined, would be the most ideal with the highest payoff of 1. The order of joining the coalition is not kept as important. Hence, any optimization techniques for calculating average payoff of a member across all coalitions (*techniques like Shapley Value*) is not very useful.

Also, the idea of bargaining sets has not been applied with further metrics, as it is currently difficult to imagine a common metric on which this inter-group coalition could bargain on issues and exchange a small payoff. Certainly, money is not a standard here and voting rights have not been established in these nebulous coalitions. However, developing voting rights would be extremely helpful for institutional design in future with more empirical evidence. As a comparison, even after two decades of mainstream existence of the internet, such governance coalitions have not been made for the ecosystem.

Though it is difficult to practically discern the difference between a 0.85 and a 0.75 payoff, the major part of the analysis hopes to communicate that a coalition with the highest payoffs of individual members would be most powerful in reaching majority consensus solutions.

6.2.2 Crisis 2: Emergency of War or Scarcity

Under situations of large scale war or scarcity, it is possible that national governments needs to exercise monetary policy, requiring more control of the money supply. How the network supports this, if it becomes popular, is an issue.

Similar to the above mentioned case, there is a possible scenario in case of experiencing emergency due to religious conflicts or natural scarcity (*climate change in the modern context*). The role of the IMF (Plassaras, 2013) in governing these situations, was mentioned as its historical responsibility on its incumbency. If the IMF could collect reserves from different member nations in bitcoins or start mining a sizeable amount of bitcoins, crisis situations could be amended. This would come along with amending its core principals of accepting only fiat currencies from member nations (*as currency reserves*), to avoid global and national shortages in cases of calamities.

Also, the United Nations could carry out governance collaboration efforts on a global level, if the effects and causes spill over. Similar to the above mentioned case, the citizen groups including think tanks and foundations, would carry out an active role in engaging popular opinion about the crisis and resources

needed to combat the effort. On a positive note (*different to the above case*), both the bitcoin foundation and business groups could include functionalities to provide crisis support, similar to the Nepal Earthquake relief offered recently. Near 65 million US dollars¹⁷⁶ by governments, companies and foundations was arranged along with in-kind relief (*food, water, manpower etc.*) for the 7.8 magnitude earthquake killing near 4400 people.

Payoffs:

The payoffs are calculated on assumption, as data for these unprecedented events (*with major bitcoin presence*) is not possible to collect through interviews or analysis. Both the National Government and Citizen Activist Groups have been given a higher payoff, though equal amount, as they can lobby the legislature and citizens through equal force and impact. The Bitcoin Foundation and Business Groups have been given an equal but lower payoff, as they would act as mere technical facilitators of support along with individual support from the organizations. The IMF/UN are given a lower payoff at the ability to steer both financial and government support internationally from its members. As the IMF has been explained to be a part of the UN¹⁷⁷, collectively they have been given a payoff of 0.2 due to aligned interests.

1. National Government (*NG*) = 0.25

2. Bitcoin Foundation (*BF*) = 0.15

3. Business Groups (*BG*) = 0.15

4. Citizen Activist Groups (*CG*) = 0.25

5. United Nations (*UN*) = 0.2

Game:

A game formation in characteristic function form is not performed here, for the sole reason that bargaining rights need to be developed theoretically first, based on certain empirical evidence as stated in the previous section. The payoff distributions do determine the power balance between the different players though. The grand coalitions of all the members would be most suitable to reach governance consensus solutions for bitcoin. The coalition having the most members with the highest payoffs, would be more powerful in moving consensus over crisis situations.

6.2.3 Crisis 3: Legality of Physical Asset Ownership Transfer on the Network

If the government services are not okay with the legality of being able to transfer ownership of physical assets (*in a decentralized way*) on the bitcoin network, services on the network can become illegal. Certainly, these decentralized services lead to revenue losses of centralized agencies. Hence, it is very important that the legality evolves simultaneously. Also, certain items related to defense, might not be acceptable to many governments, to be transferred on the bitcoin network anonymously.

¹⁷⁶ Nepal earthquake donations: Who's sending what: <http://money.cnn.com/2015/04/27/news/nepal-earthquake-donations/>

¹⁷⁷ International Monetary Fund (IMF) is sometimes considered to be a specialized agency. It is part of the United Nations system and has a formal relationship agreement with the UN, but retains its independence: https://en.wikipedia.org/wiki/List_of_specialized_agencies_of_the_United_Nations

The importance of the government being okay with regulating at the edges, has been expressed by industry experts. As explained by Fred Wilson, Partner, Union Square Ventures, with decentralized asset transfer technicalities, the governments should accept their new role of regulating at the edges¹⁷⁸ as people matured to transfer goods among themselves. Hence, systemic taxation could also be lowered in respective places for invigilation and violations.

A coalition could have a major role in this case rather than using brute law enforcement tantamount to brute force to bring settlement. The different members could be:

1. National Government (*NG*)
2. Citizen Activist Groups (*CG*)
3. Business Groups (*BG*)
4. Bitcoin Foundation (*BF*)

To understand the technical limits and flexibility of the algorithm and maybe set limitations for certain sensitive items liking drugs, guns, pornography etc. the role of the Bitcoin Foundation is critical. Also, the citizen groups always help to understand the majority viewpoint and criticisms. The Business Groups help to explore how safely and efficiently the assets can be transferred on the system. Finally, the view point of the government is most important as replacing old centralized, specialized governance agencies from the point of view of job creation and national security are very important. As stated by Superintendent of New York Financial Service, Benjamin Lawsky¹⁷⁹; the choice between promoting innovation and preventing money laundering has always been the latter.

Payoffs:

The payoffs are calculated on assumption, as data for these unprecedented events, is not possible to collect through interviews or analysis. The National Government has been given the highest payoff due to the independent legislature (*bound to be conservative*) and responsibilities of managing a nation state on its side. Next, the Citizen Activist Groups have been given a high payoff, as they can lobby the legislature and citizens through popular opinions and analysis, by independent think tanks like Coin Center¹⁸⁰. Finally, the Bitcoin Foundation and Business groups have been given an equal but lower payoff, as they have the ability to be technical facilitators for innovation, keeping in mind public approval (*foundation*) and private profit/competition (*businesses*).

1. National Government (*NG*) = 0.5
2. Bitcoin Foundation (*BF*) = 0.1
3. Business Groups (*BG*) = 0.1
4. Citizen Activist Groups (*CG*) = 0.3

¹⁷⁸ NYDFS PUBLIC HEARING REGARDING VIRTUAL CURRENCIES 28th January, 2014

Panel 1- The Investor Perspective: The Future of Virtual Currencies: Fred Wilson, Partner, Union Square Ventures:
<http://www.totalwebcasting.com/view/?id=nysdfs>

¹⁷⁹ Bitcoin Advocates Speak Up:

<http://www.wsj.com/articles/SB10001424052702303553204579348811827084626>

¹⁸⁰ <https://coincenter.org/>

Game:

A game formation in characteristic function form, is not performed here for the sole reason that bargaining rights need to be developed theoretically first, based on certain empirical evidence as stated in the previous sections. The payoff distributions do determine the power balance between the different players though. The grand coalitions of all the members would be most suitable, to reach governance consensus solutions for bitcoin. The coalition having the most members with the highest payoffs, would be more powerful in moving consensus over crisis situations.

6.2.4 Crisis 4: Hostile 51% Takeover Attack on the Network

A hostile 51% attack (*mining using computing power*) from a mining group within the bitcoin network, is always possible. The honest members must have communication and governance intact to counteract such situations.

This is a major case of issue explored by (Kroll et al., 2013). It was suggested, that incase within the bitcoin network such a case arrives; the honest members must unite along with the miners who play a crucial role in maintaining the system and verifying the transactions. In case, the majority group aims to destroy the network, they would lose value as well, hence it is not a rational scenario when the major purpose, is domination and getting priority for choosing transactions.

However there are major disadvantages with a 51% attack. The dominating group¹⁸¹ has the ability to spend the same coins twice, reject competing miner's transactions and take higher fees from people with large holdings of bitcoin or on their personal preference. Worst of all, a malicious player with a majority holding could deny services selectively, to the entire Bitcoin network while holding the system ransom to its demands. These have been addressed as well, since double spending the same coins and exchanging for money (*through the exchanges*) would create legal issues of fraud. Also, rejecting or stopping the bitcoin network would halt the entire network as well, creating losses for the incumbent. Keeping this in mind, it cannot be denied that a 51% attack must be avoided, as the Bitcoin Foundation still works to understand caveats, of how to prevent this as it is a serious theoretical threat to the system.

As stated earlier in Chapter 2, both Litecoin and Bitcoin had instances of a 51% attack where incase of Litecoin nothing major was observed and with Bitcoin, the mining pool soon retracted power on negative publicity and bitcoin price falling 2%. This directly effects the profits of the mining pool, hence acts as a natural deterrent.

A coalition could have a major stabilizing role in this case rather than using brute law enforcement tantamount to brute force to bring settlement. The different members could be:

1. National Government (*NG*)
2. Citizen Activist Groups (*CG*)
3. Miners (*M*)

¹⁸¹ After reaching 51% network power, Bitcoin mining pool says "trust us":
<http://arstechnica.com/security/2014/06/after-reaching-51-network-power-bitcoin-mining-pool-says-trust-us/>

4. Bitcoin Foundation (BF)

5. Business Groups (BG)

If by the activities of citizen activist groups and journalists, the dominant mining group with 51% or more power does not retract on threat of losing profits and ethics, the bitcoin foundation could always take government support through legislature, to understand how the rights of the members on the network are being violated. Also, the honest miners must unite to not detract on the wrong side. Finally, the Business Groups would always offer support, in case there are double spending of coins and any malicious efforts to gain unethical profit.

Payoffs:

The payoffs are calculated on assumption, as data for these unprecedented events with major bitcoin presence is not possible to collect through interviews or analysis. The honest miners have been given the highest payoff, due to their power in further crashing in the system and preferring short term profit over long term loss of the entire network which is a classic Prisoner's dilemma¹⁸² in Game Theory among the miners. Here mutual co-operation is less profitable, for the individual miners than defecting for individual benefit. However, when constructed across the various player's, it pans out like a normal game. The Citizen Groups have been given the next highest payoff on their ability to influence public opinion and thus effecting the monetary value of bitcoin which directly effects profits of the ruling mining pool. As citizen sentiment goes negative, people lose faith in the ability of bitcoin to transfer value ethically, hence plummeting its value. Also, the National Government has been given a similar payoff (*2nd highest*) due to its ability, to move the legislature or pass laws in case of bitcoin citizen rights being abused. The bitcoin foundation also shares the same amount of payoff, due to the possibility of finding a technical solution to preventing any majority attacks, as is the case with Litecoin (*alternative digital currency*) where no mining pool exists. Finally, the business groups have been given the lowest payoff in their important role of aiding the law enforcers, in case of any money being exchanged (*or goods and services*) in an awkward manner.

1. National Government (NG)= 0.2

2. Citizen Activist Groups (CG)= 0.2

3. Miners (M)= 0.3

4. Bitcoin Foundation (BF)= 0.2

5. Business Groups (BG)= 0.1

Game:

A game formation in characteristic function form is not performed here for the sole reason that bargaining rights need to be developed theoretically first, based on certain empirical evidence as stated in the previous section. The payoff distributions do determine the power balance between the different players though. The grand coalitions of all the members would be most suitable to reach governance

¹⁸² Prisoners Dilemma: The prisoner's dilemma is a canonical example of a game analyzed in game theory that shows why two purely "rational" individuals might not cooperate, even if it appears that it is in their best interests to do so. It was originally framed by Merrill Flood and Melvin Dresher working at RAND in 1950: https://en.wikipedia.org/wiki/Prisoner%27s_dilemma

consensus solutions for bitcoin. The coalition having the most members with the highest payoffs, would be more powerful in moving consensus over crisis situations.

6.2.5 Crisis 5: Power abuse by the Bitcoin Foundation

Also, bitcoin could be seen like a monarchy with five core developers of the bitcoin foundation having complete control over maintaining the system code. Even though it is open source and discussions take place in the community, there could be issues of trust. This is due to the fact, that there are no popular elections through voting for the members, as found in parliamentary democracy for representatives.

This crisis situation should always be easy to manage as bitcoin is inherently a public currency, with a 51% majority capable of expressing their views and getting their voices heard. As the systemic design is such, which is observed in the previous examples; members from different groups need to co-operate. Hence, the status of a monarchy rather than facilitator for the bitcoin core developers, will not last the test of time.

6.2.6 Crisis 6: Bitcoin Fork¹⁸³ and disagreement on the history

This is an interesting crisis situation as by design, only one version of the history of transactions are available on every link of bitcoin, with every member. This is to create an uncontroversial version of truth. It is not possible that miners disagree for a long time on which transactions should be ratified or not, as they systemically lose computing resources. When such an issue happens, resolution is imminent with stakeholders. As noticed in July, 2015 a division happened which continued for six mined blocks. The bitcoin foundation henceforth, issued a warning to the businesses to prevent false transactions, which could indulge in double spending money and defrauding the companies through sophisticated ways. The case was resolved soon and the fork was removed.

This is not a case of aberration for bitcoin as forks happen on a regular basis, due to it being a decentralized currency, with no one guiding the overall transactions and which blocks should get mined. However, the scale of these forks are small and resolved, when miners collectively realize the majority block chain.

6.2.7 Crisis 7: A mining strike as in Block 289791¹⁸⁴

Again, this is a rare case as noticed in 2014 when a group of miners mining a block, decided to stop transactions for a small time and then after a day, declared that they would be mining only on non-zero transaction fees. However, collectively the strike failed to gain momentum, due to many competing miners ready to mine for bitcoins generated as their reward. As and when the miner groups gain momentum, they would be able to bring out their grievances. However the lack of a majority 51% mining group, should keep these rights within practical limitations. Hence, the game could be modeled as in Crisis 4.

¹⁸³ <http://www.coindesk.com/double-spending-risk-bitcoin-network-fork/>

¹⁸⁴ It's just a game: a handful of scenarios in the Bitcoin world: <https://miki.it/blog/2014/11/1/its-just-a-game-handful-of-scenarios-in-the-bitcoin-world/>

Hence, it is observed that bitcoin's inherent system design, compels to create coalitions for effective governance, especially in crisis situations. It is not possible for an elected government to have majority control over the decisions, due to bitcoin being governed by a majority consensus. Hence, the other important stakeholders like miners, citizen activist groups, business groups, bitcoin foundation and the United Nations would need to be involved. Establishing voting rights for these different members would be extremely helpful in developing effective coalitions, which could bargain when needed, to reach consensus on decision making. As a reality check, these have not been established for the internet ecosystem, after two decades of existence. Further, it is observed that in the seven contingencies analyzed, the national government has one of the highest payoff's always, however never more than 50%. This compels, co-operation with other stakeholders in every situation.

Chapter 7: Conclusions & Recommendations

This section presents the final conclusions, recommendations, research limitations, future research and reflections.

7.1 Conclusions

Recently an article appeared in the Financial Times¹⁸⁵ attributing Bitcoin's recent (*November, 2015*) price surge to a pyramid scheme in China through exploiting naive users. The price has been dropping steadily since. Currently, it stands near 400 US dollars. The 2014 Nobel Prize winning economist warned in an article, that bitcoin has high volatility and hence would be unable to serve as a currency. This value volatility is seen as a necessary side-effect of its exponential nature (*highlighted in section 5.2.2 through the 6D modern technology framework*) and seen in the list of figures at the end. To concretely specify when the value would be more stable, is currently not possible.

The technology behind bitcoin, blockchain technology has always been praised and is seen as a major breakthrough for increasing efficiency through arranging private databases more efficiently. Private networks through alternative digital currencies like Ripple among other solutions, are something major banks are keen on implementing by 2016¹⁸⁶. As this would evade the issue of any challenges posed by bitcoin to fiat currencies, it is popularized as the major purpose of bitcoin technology.

The ability to transfer value in a decentralized manner is not given as much importance, which has been earlier cited as offering the major value source for bitcoin. It is poised to influence the near future, with the current pessimism, being a good reality check for the expectations from bitcoin. As cited from literature, the ability of bitcoin to function both as a currency and commodity, is a new phenomenon used historically in circles like prisons. The ability to create both public and private networks on its protocol could in future, could give bitcoin mainstream acceptance. The issue of private networks being able to run on bitcoins is put to rest when compared with the internet, where private corporations like Google are able to exist through the force of law and cryptography. This is despite the fact, that theoretically, everyone is connected and all information can be accessed by anyone. The alternative digital currencies would offer multiple variations, which is only good for the ecosystem, to understand how to improve and adapt the bitcoin code while providing valuable competition. The only advantage bitcoin has in this sphere, is the first mover advantage with offering a decentralized protocol. Hence, it is possible that another digital currency with better alignment to societal needs gains majority acceptance.

A major issue of concern is how the legality evolves with technology decentralization both across bitcoin and other domains. Interestingly, the current Prime Minister of UK in his TED talk¹⁸⁷ explained how the role of the government has evolved. From the age of the kings, to the age of city states and finally to the incumbent age of information revolution in the 21st century. The government has to play the role of a facilitator rather than ruler, according to him. Keeping in line with this, as and when the decentralized monetary system gains more traction, legal compliance is hoped from the government, if only to support citizen viewpoint, business growth and resource efficiency. As seen in the internet regulation

¹⁸⁵ Bitcoin's place in the long history of pyramid schemes: <http://www.ft.com/intl/cms/s/0/1877c388-8797-11e5-90de-f44762bf9896.html#axzz3r73D8KPO>

¹⁸⁶ Banks could use bitcoin technology by next year: study: <http://www.cnbc.com/2015/11/11/banks-could-use-bitcoin-technology-by-next-year-study.html>

¹⁸⁷ The next age of government: https://www.ted.com/talks/david_cameron?language=en

bill SOPA (Stop Online Piracy Act) in the US¹⁸⁸, after having bipartisan support in 2012, it was not taken forward due to blackout protests by Wikipedia and other internet organizations. This bill was supported by the entertainment industry due to piracy, but offered negative attributes of online control as well, to ordinary citizens. Here, lies the power of citizen groups in the information age and the importance of organizing governance coalitions for taking decisions. This has been attempted in Chapter 6 for bitcoins, keeping in mind different contingencies.

In its ability **to answer the initial research question** and sub questions posed, the thesis proposes certain ideas. The main research question tried to investigate how bitcoin could be regulated while protecting against illegal activities and supporting technology decentralization. As studied, significant challenges exist in perfect regulation of bitcoin, through current organizations, due to anonymity tools like TOR and its inherent decentralized structure. Also, its idea of decentralization is not completely supported through classical theory of appropriate technology, due to excessive material focus and diminished spiritual focus. However, as studied in chapter 6, through regulatory coalitions across the different stakeholders, it is possible that contingencies could be avoided while avoided dictatorial habits, due to every decision being moved through majority consensus. Hence, it is impossible for one stakeholder to have majority control over the entire bitcoin ecosystem, as has been observed for the internet ecosystem.

The **first sub-question** investigated the issue of tax evasion in bitcoin, keeping in mind its decentralized peer to peer structure. As researched, organizations like the OECD (*Organization for Economic Co-operation and Development*) have clearly mentioned that bitcoin's ability to function as legal tender is hampered, by its inability to offer practical solutions for tax collection. It is extremely difficult to trace each and every transaction on the bitcoin network, even though all transactions are publicly available, due to the bitcoin addresses being tantamount to email addresses. This is due to its decentralized structure, with no central authority ratifying every transaction. Further, the classification of bitcoin as commodity not currency, creates issues for incumbent organizations like the IRS (*Internal Revenue Service*) in the US, for tax collections. Tracking every purchase creates practical hurdles as minors taxes could emerge from purchases of coffee to milk. However, through allowing governance coalitions to work together, from the bitcoin foundation/businesses/citizen activist groups and national governments middle ground could certainly be reached, as explored in chapter 6. An evolution, of the role of systemic taxation could be even seen, where the national government is able bid for projects on the bitcoin network like current crowd funding applications by foundations and corporations.

The **second sub-question** dealt with economic issues of weather, by theory bitcoin could function as a medium for money. The major issues were, weather it possesses any intrinsic value which is seen as essential according to both Keynesian economics and Austrian economics. Mainstream experts from both schools of thought, are critical of bitcoin in being able fulfill this function, as the medium lacks any inherent value prior to its use. It is digital medium being just 0 and 1 binary code. Successfully reducing transaction costs as seen in bitcoin, is a necessary however not a sufficient condition. An econometric model has been cited in this thesis, suggesting the possibility of its independent existence outside fiat currencies, though one year of data has limited reliability. Overall, it is observed that the only possible parallel to bitcoin, could be seen through the success of the internet in the information dimension, where legal public and private organizations exist. This was mostly denied by experts from around the table, initially. In being able to offer an efficient and regulated platform for value to flow, through asset

¹⁸⁸ Obama Says So Long SOPA, Killing Controversial Internet Piracy Legislation: <http://www.forbes.com/sites/johngaudiosi/2012/01/16/obama-says-so-long-sopa-killing-controversial-internet-piracy-legislation/>

ownership transfer of physical goods among other standard functions of a currency, bitcoin could evolve the traditional requirements of a successful money system.

The **third sub-question** dealt with the ethical impacts of bitcoin on society, as judged through two frameworks. Firstly, as a large social experiment framework, bitcoin could have irreversible impacts on society, due to its novel nature. Hence, it must be governed in a democratic manner with strong emphasis on human well being. The democratic angle has been questioned, due to the de facto Bitcoin Foundation which is not popularly elected, though the majority consensus and open source code, does guarantee some democracy. This issue has been further explored through the crisis situations for governance coalitions in Chapter 6, and successfully resolved. Secondly, conducting an Ethical Impact Assessment on the basis of certain values, it is seen that there are more factors, influencing bitcoin negatively/ambivalently than in a positive way in a ratio of 4:3. This is based on qualitative values, hence it cannot be quantitatively analyzed to a large degree. Mostly, the issue of privacy, sustainability and stable international relations are grave to consider and worked upon.

The **fourth sub-question**, dealt with understanding whether bitcoin promotes technology decentralization in an appropriate manner according to classical and modern frameworks. This answer mainly depends on the definition and understanding of decentralization. The traditional ideas of thinkers like Dr. M.F Schumacher and M.K Gandhi propounded a materially and spiritually balanced idea of localized decentralization. This was classically termed as an 'appropriate technology'. There was a certain angst against modern technologies, due to negative stated impact on human moral values, social inclusion and non-violence ideology collectively dubbed as spiritual. In modern times, the 6D framework as presented by the Singularity University, is a materially enhanced idea of decentralization where functioning and decision making is localized. It is fair to say, that by design, bitcoin certainly promotes the 6D framework of decentralization and falls short in the spiritual aspect of a traditional decentralized system. This factor could be addressed independently by accentuating local meetups and local cultural bonds. However, this has not been currently cited as a major priority; as is expected by the traditional appropriate technology framework.

The **fifth sub-question** tried to answer the broad question of how bitcoin could be regulated, keeping in mind its inherent structure and status quo in governance. It is observed that bitcoin's inherent system design, compels to create coalitions for effective governance, especially in crisis situations. It is not possible for a single actor like an elected government, to have majority control over the decisions, due to bitcoin being governed by a majority 51% consensus. Hence, the other important stakeholders like miners, citizen activist groups, business groups, bitcoin foundation and the United Nations would need to be involved. Establishing voting rights for these different members would be extremely helpful in developing effective coalitions, which could bargain when needed, to reach consensus on decision making. As a reality check, these have not been established for the internet ecosystem after two decades of existence. Further, it is observed that in the seven contingencies analyzed, the national government has one of the highest payoff's always, however never more than 50%. This compels, co-operation with other stakeholders in every situation, as people on the blockchain could reverse decisions, on gathering majority support (*greater or equal to 51%*), when decisions are forced upon them.

Lastly, on a practical level, bitcoin allows/needs very centralized intermediaries like wallets/exchanges/payment processors to exist. This is in line with the idea of decentralization by the United Nations Development Programme (*UNDP*) where they see it is as complementary to centralization and not a substitute. Hence, apart from pure idealism, results matter the most. If the bitcoin community fails to deliver technical systems which are supported by society, adaptation will not

occur. If it isn't bitcoin, another version (*of the hundred odd competing currencies*) offering balanced technical decentralization would emerge sooner or later. This would be a challenge to fiat currencies, as the idea seems to have taken seed.

7.2 Recommendations

The major recommendation offered would be to organize an international coalition group for bitcoin, to take care of crisis situations as mentioned in Chapter 6. As seen with the failure of SOPA regulation in the US, these coalitions are tricky to organize. It is evident that online piracy is an issue, but until both the entertainment industry and online activist groups are brought to the negotiating table with the government, progress will be stalled. Also, to be able to set up a common denomination for bargaining power among the coalition members, would be extremely helpful in analyzing suitable outcomes. This could not be limited to only money or voting power as nothing is organized yet.

If the IMF could propose in future, collecting certain amount of money from its member nations in bitcoin; a global catastrophe would be more easier to manage. Finally, any excessive efforts by the government to support bitcoin, might be counter-intuitive in fueling a bubble. Hence, a wait and watch game with dynamic regulation on detailed parts like derivatives etc. would help in the system, in surviving on merit.

Also, to be able to effectively manage taxation issues, is a responsibility the Bitcoin Foundation must take on more strongly. Though startups on the bitcoin network could solve this in principle, by allowing the government to bid on projects; the traditional concerns of governments must be addressed. Through organizing meetings with national governments and international organizations like the OECD and the UN, middle ground solutions must be attempted and implemented, to guarantee government support. This could range from information sharing for legally binding taxation on accounts to setting aside certain part of a transaction for taxation purposes.

Further, making concrete efforts to align the decentralization of bitcoin to classical appropriate technology frameworks and modern day ethical frameworks must be made. This would again require collective action of the coalitions. However the Bitcoin Foundation must take the lead in atleast voicing such issues. By giving the human contact and social inclusion more emphasis, local culture and values could develop, which would hold a bitcoin ecosystem together much stronger, than just pure technology merit.

Finally, efforts to scale bitcoin appropriately and lower energy requirements, would help get the sustainability stamp for the eco-system. It is understood that decentralized systems are initially more energy intensive than centralized ones; however innovation through technology startups must address this problem more seriously.

7.3 Research Limitation

The major limitation of the research is a proper precedent apart from the internet, which works purely in the information and not the monetary value domain. Also, the inability to gather appropriate data for analysis, served as a deterrent to carry out further analysis of the coalitions in Chapter 6. Further, the payoff's are calculated by intuition and theory rather than raw data gathered. This was deemed tough,

as an effort to reaching out to the coalition members was not received well. This limits the ability to carry out a full empirical analysis.

Finally, the inability to use econometrics to really analyze bitcoin for its worth, is a serious limitation in being able to reach out to the critics. Hence, it lies theoretically analyzed which is certainly not enough. The one model found by researchers at Temple University, only uses a year of data and hence does not guarantee complete reliability. This is because recently, bitcoin has been more stable than its initial years, which is again not stable enough.

7.4 Future Research

The ability to actually set up and implement a workable analytical metric of decentralization, would be very helpful, keeping in mind the modern infrastructures and those to follow. This would help understand the actual decentralization in an ecosystem. Hence, a combination of both modern and traditional theories of decentralization, could be analyzed together.

Also, to be able to develop coalitions with data from the incumbent members about the crisis situations, would be extremely helpful to see how much bargaining and stability the coalitions can show. With an actual metric for transferring utilities among them (*money/voting power/something else*), it could be possible to see how these dynamic coalitions can execute stable governance.

Further, being able to judge how fast the bitcoin money supply should grow and whether it should be static or dynamic, to avoid negative impacts of deflation, will be helpful in evolving a better currency. This could be further studied with the bitcoin velocity data (*List of Figures*) and analyzed appropriately in due time.

7.5 Reflection

As a final reflection a balance between analyzing through induction and deduction is critical for novel systems. Over reduction and over generalization across domains does not lead useful results. Though, there has been an effort to provide a view point of bitcoin from different domains, critical in-depth analysis is offered wherever possible. To examine, if bitcoin truly abides by all the different theories be it economic, political or technical has not been entirely proven with limitations in empirical evidence.

Also, the major challenge currently exists in getting people to consider bitcoin or another decentralized digital currency as a backbone of blockchain (*database technology*). Promoting private corporations to have their own versions of blockchain technology rather than building these unique private corporations (*through blockchain technology*) on a public bitcoin layer is an essential difference. In the case of the internet (*in the early 1990s*), this is tantamount to major telecom giants like AT&T¹⁸⁹, implementing their own version of a private internet, which was carried out to steer public support and prevent any major disruption. However, it has not stood the test of time and a public internet (*with private corporations functioning on top of it*) prevails.

¹⁸⁹ Wired Money 2015 - Andreas M Antonopoulos - Bitcoin is the real disruptor:
https://www.youtube.com/watch?v=_0mykANOMGQ

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Appendix: Digital Media Outlook (Chronological order- Aug'13-Sep'15)

1. In 2013, Bitcoin showed volatile price points of \$12¹⁹⁰, \$237, \$50, \$400¹⁹¹ and \$1200 chronologically and settled in around 800\$ in early 2014. Currently, it is near 200\$ with the entire 'Market Price in USD' history in the List of Figures (at the end). The thesis selectively presents digital media arguments fitting their subsection. This section collectively presents the remaining ideas provided by the media in separate paragraphs chronologically to give a popular understanding of the ecosystem.
2. In August, 2013 a judgment was passed against the hedge fund, Bitcoin Savings Trust¹⁹². According to the U.S. Security and Exchange Commission which filed the case, around 700,000 bitcoins in investments amounting to more than \$4.5 million (based on the average price of bitcoin in 2011 and 2012) were offered and sold. When the SEC filed the case, the 700,000 bitcoins were worth in excess of \$60 million.
3. In November, 2013 the spike in bitcoin value was due to large no of businesses¹⁹³ joining in, along with the financial crisis situation in Cyprus. The University of Cyprus¹⁹⁴ also started accepting bitcoin as tuition fee.
4. In January, 2014, BitInstant (bitcoin business) CEO Charlie Shrem was arrested and charged with one count of conspiracy to commit money laundering and one count of operating an unlicensed money transmitting business, which 'schemed to sell over \$1 million in bitcoins to criminals bent on trafficking narcotics on the dark web drug site, Silk Road' as mentioned by Preet Bharara¹⁹⁵, the US Attorney for the Southern District of New York. The Winklevoss brothers¹⁹⁶ were investors in BitInstant, a bitcoin exchange service based in New York that suspended operations last July. Charlie Shrem, aged 24 who was seen as a darling of the bitcoin community resigned from the Vice President post of the Bitcoin Foundation (main NGO maintaining bitcoin ecosystem).
5. Also, the Winklevoss brothers put in a large investment near 10 million to create an (Exchange Traded Fund) ETF¹⁹⁷ of theirs to support financial trading of bitcoins.

¹⁹⁰ 2013: Year Of The Bitcoin: <http://www.forbes.com/sites/kitchconews/2013/12/10/2013-year-of-the-bitcoin/>

¹⁹¹ China fuels Bitcoin surge to record high: <http://money.cnn.com/2013/11/12/investing/bitcoin-record-high/>

¹⁹² Sorry, libertarians: Bitcoins are currency and can be regulated under U.S. law, says judge:

<http://www.pcworld.com/article/2046188/sorry-libertarians-bitcoins-are-currency-and-can-be-regulated-under-u-s-law-says-judge.html>

¹⁹³ The Bitcoin Boom: <http://www.newyorker.com/tech/elements/the-bitcoin-boom>

¹⁹⁴ Students pay Cyprus university in bitcoins: <http://www.euronews.com/2013/11/21/cyprus-nicosia-university-first-to-accept-tuition-fees-in-bitcoins/>

¹⁹⁵ New York announces plans for bitcoin 'license' amid high-profile arrest: <https://www.rt.com/usa/bitcoin-regulations-new-york-320/>

¹⁹⁶ The Winklevoss brothers came to limelight during their legal conflict over Facebook ownership with founder Mark Zuckerberg at Harvard University and were featured in a Hollywood movie. In a public statement (<http://www.cnbc.com/2013/11/12/the-winklevoss-brothers-bitcoin-worth-100-times-more.html>), they advocated that the bitcoin value could be 100 times more. The brothers have invested around 11 million in April, 2013 in bitcoins which was valued at well over 40 million currently by the year end and dropped subsequently with bitcoin price fall in recent times.

¹⁹⁷ Winklevosses: Bitcoin worth at least 100 times more: <http://www.cnbc.com/id/101190181>

6. Meanwhile, the Chinese¹⁹⁸ people mostly see bitcoin like an investment just like the 80% of Coinbase (popular bitcoin wallet service) users who are currently saving and plan to spend in the future. It could follow the typical 80-20 rule.

7. A major gaming player Zynga¹⁹⁹ stated accepting bitcoin which supposedly pushed the price beyond \$1000.

8. Fred Wilson²⁰⁰, who is a partner at the venture capital firm Union Square Ventures explained that bitcoin miners are running the system like Amazon web service (backend technology managers) personnel, who by definition cannot overthrow the system. Any such fear is unwarranted.

9. Fred Ehrsam²⁰¹, Coinbase suggested that there are a lot of regulatory requirement for bitcoins but credit cards are far more risky than decentralized bitcoin where wallet service coinbase takes on risk

10. In March, 2014 Newsweek reported on finally cracking down the supposed mysterious founder of bitcoin, Satoshi Nakamoto²⁰². The person's background was explained as an eccentric, brilliant, cryptic and secretive engineer who denied any details of the project on further probing and ceased contact. Living a humble lifestyle he was defined by his family as an extremely intelligent, idealistic and liberal minded engineer/physicist who suggested that he had worked on many classified projects and would never admit to anything. On reaching his residence, the local police was informed and media dispersed. The story created furor in the bitcoin ecosystem with veterans suggesting the importance of privacy as nothing was allowed to be confirmed and carrying on with the project. As the founder, a larger sum of bitcoins which were the first ever mined are owned by Satoshi Nakamoto. Enthusiasts are keeping a keen watch on those to learn more of the mysterious founder.

11. The Bitcoin boulevard²⁰³, Netherlands was an effort to expand the influence and business of bitcoins. All the shops along the two canal-side streets in the city centre started accepting bitcoins. The two streets running along the canal – Bierkade and Groenewegje – changed their name to the ‘Bitcoin Boulevard’ unofficially which garnered a lot of positive press on their enthusiasm and openness.

12. In May, 2014 it was reported that one third of all Kenyans²⁰⁴ already have access to bitcoin through popular mobile payment service, M-pesa. The remittance industry on the whole is estimated as a trillion dollar industry which bitcoin could hopefully impact by significantly lowering transaction rates.

13. In August, 2014 it was reported that a survey conducted by mobile payment company JANA²⁰⁵ suggested that 74% of Kenyans feel comfortable investing in bitcoins and over half of the correspondents from Asia and Africa are confident investing in bitcoin.

¹⁹⁸ What The Bitcoin Bubble Really Says About The Cryptocurrency: <http://readwrite.com/2013/11/20/bitcoin-bubble-investment>

¹⁹⁹ Bitcoin Tops \$1,000 Again as Zynga Accepts Virtual Money
<http://www.bloomberg.com/news/2014-01-05/bitcoin-tops-1-000-again-on-adoption-by-zynga-amid-wider-usage.html>

²⁰⁰ NYDFS Virtual Currency Hearings, Day 1, Panel 1: <https://www.youtube.com/watch?v=TZW7R7FPIJY>

²⁰¹ NYDFS Virtual Currency Hearings, Day 2, Panel 2: <https://www.youtube.com/watch?v=8Z3-DA7aFCU>

²⁰² The Face Behind Bitcoin: http://mag.newsweek.com/2014/03/14/bitcoin-satoshi-nakamoto.html?_ga=1.82681494.1678948380.1384793663

²⁰³ Dutch Streets Adopt Cryptocurrency, Become ‘Bitcoin Boulevard’: <http://www.coindesk.com/dutch-streets-adopt-cryptocurrency-become-bitcoin-boulevard/>

²⁰⁴ The Boring Bitcoin Report: May 19-26: <http://www.forbes.com/sites/perianneboring/2014/05/26/the-boring-bitcoin-report-may-19-26/>

14. Also, EU based Bitbond²⁰⁶ raised a seed investment contributing to Europe's growing bitcoin sector. It is mainly looking to lend to small businesses which have been operating for two to three years but cannot get bank finance in order to create a niche for itself.

15. In September, 2014 it was reported that KnCMiner²⁰⁷ (business selling mining machines to people/businesses) made 70 million dollars in revenue for the first year of its operations. They received \$14 million as venture capital but had issues with people asking for refund due to the long waiting list and price volatility of bitcoin which hampered calculated returns on purchase. Similar pattern is seen with other bitcoin companies selling mining equipment.

16. Apple pay²⁰⁸ is seen as a very good opportunity for digital currencies as reported in September, 2014. As explained, Google android had developed an open source ecosystem which became the top mobile operating system once Apple did the basic work of building a closed eco-system with customer retention, satisfaction and belief. A similar pattern will be seen in payment systems once Apple Pay creates an advance belief and a large pool of customers comfortable with online payments. Digital currencies like bitcoin should take the lead henceforth being more cheaper, efficient, secure and popular than Apple pay due to their open source architecture.

17. In Oct, 2014 Sky news reported that terrorist organization ISIS²⁰⁹ proposes using bitcoin to fund global jihadists with services like Dark Wallet which makes transactions and payments untraceable.

18. Also, Coinbase²¹⁰ (popular digital wallet service) CEO Brian Armstrong suggested that, Bitcoin has moved through three bubble periods despite which, deposits are growing with people signing up and using currency more than before. Their internal team statistics and reports confirmed the same.

19. In wake of the Nepal earthquake, See Change Foundation saw major bitcoin contribution in April, 2015. Erik Bouchard²¹¹ from the team said that over 100 bitcoin donations were received in 36 hours from \$1 to \$100 for the Nepal based charity.

20. In May, 2015 Boston based startup Circle²¹² raised \$50 million in investment from Goldman Sachs which had the media very excited due to Goldman Sachs being very vocal earlier on the bitcoin threats and issues. Circle also drew investment support from China based IDG Capital Partners.

²⁰⁵ Bitcoin Growing Rapidly in Emerging Markets

<https://www.cryptocoinsnews.com/bitcoin-momentum-growing-emerging-markets/>

²⁰⁶ VC Funding Boosts Global Growth For Berlin-Based Bitcoin Startup

<http://www.forbes.com/sites/alisoncoleman/2014/08/13/vc-seed-funding-spells-growth-for-berlin-based-bitcoin-loans-start-up/>

²⁰⁷ For KnCMiner, Time to Forget Selling Bitcoin Machines To At-Home 'Miners'

<http://blogs.wsj.com/venturecapital/2014/09/05/for-kncminer-time-to-forget-selling-bitcoin-machines-to-at-home-miners/>

²⁰⁸ Is Apple Pay a bitcoin killer?: <http://www.cnn.com/id/101988826>

²⁰⁹ US Military Command Holds Informational Meeting With Bitcoin Industry

[http://www.coindesk.com/us-military-command-holds-educational-meeting-bitcoin-industry/?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+CoinDesk+\(CoinDesk+-+The+Voice+of+Digital+Currency\)](http://www.coindesk.com/us-military-command-holds-educational-meeting-bitcoin-industry/?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+CoinDesk+(CoinDesk+-+The+Voice+of+Digital+Currency))

²¹⁰ Coinbase CEO Brian Armstrong Shares His Vision For The Future Of Bitcoin

<http://techcrunch.com/2014/10/21/coinbase-ceo-brian-armstrong-shares-his-vision-for-the-future-of-bitcoin/>

²¹¹ Bitcoin Community Rallies to Aid Nepal Earthquake Victims

<http://www.coindesk.com/bitcoin-community-rallies-to-aid-nepal-earthquake-victims/>

21. Also, NASDAQ²¹³ planned a private blockchain (main database of bitcoin) technology to keep track of its private transactions. This led to an interesting hypothesis that the bitcoin ecosystem would sooner than later split between the supporters of the public network and those of the private network. Bitcoin might not be going to Wall Street financial center but its database technology certainly will.

22. Bitcoin startup 21²¹⁴ raised \$75 million in a series C round and partnered with Intel to build a chip allowing consumers to receive and mine bitcoins with everyday devices. This would help facilitate a real time marketplace on the internet for micro transactions. Also, it would allow developers to block user's unless they can generate small amounts of bitcoin to pay for services like a web application, wireless internet and add free web browsing.

23. NASDAQ²¹⁵ also announced an open asset protocol creating private market systems to better manage the pre IPO (Initial Public Offering) stage of company stocks.

24. Also, two New Jersey state legislators introduced a Digital Job Creation Act²¹⁶ for tax breaks in bitcoin businesses which they believe will help in job creation for their state.

25. An Australia based sustainability think tank²¹⁷ cautioned that bitcoin could eventually consume 60% of the annual global electricity production which is disputed by KncMiner (popular company making mining equipment) on calculations.

Switzerland²¹⁸ announced setting up of the first bitcoin bank in the world. Being very active in the financial world, this news was welcomed by many bitcoin enthusiasts.

26. In June 2015 Barclays²¹⁹ bank announced working with Swedish startup Safillio to explore the blockchain technology (bitcoin database) in reducing costs. The interest in private networks by big banks received a mixed reaction from some of the bitcoin community as the big banks have not been very supportive of the open nature of bitcoin.

27. It was reported that ten times as many Greeks are trading at the Bitcoin.de²²⁰ (popular European service) than before due to possible Greek exit from the European Union. Also, bitcoins are harder to get in Greece as there is a single bitcoin ATM in the entire country which limits spending avenues. Bitcoin

²¹² Bitcoin in the Headlines: Media Ga-Ga for Goldman Sachs

<http://www.coindesk.com/bitcoin-in-the-headlines-media-ga-ga-for-goldman-sachs/>

²¹³ This Experiment Shows Why You Should Take Bitcoin Seriously

<http://time.com/3853765/bitcoin-nasdaq/>

²¹⁴ Inside 21's Plans to Bring Bitcoin to the Masses

<http://www.coindesk.com/21-intel-bitcoin-mining-strategy/>

²¹⁵ Bitcoin May Never Make It to Wall Street, But Its Tech Will

<http://www.wired.com/2015/05/nasdaq-bringing-bitcoin-closer-stock-market/>

²¹⁶ New Jersey Legislators Propose Tax Breaks for Bitcoin Businesses

<http://www.coindesk.com/new-jersey-legislators-propose-tax-breaks-for-bitcoin-businesses/>

²¹⁷ Think Tank Reignites Debate Over Bitcoin Mining's Environmental Effects

<http://www.coindesk.com/think-tank-debate-bitcoin-mining-environment/>

²¹⁸ Switzerland To Open Bitcoin Bank As Crypto "Fort Knox" Relocates To Zurich

<http://www.zerohedge.com/news/2015-05-27/switzerland-open-bitcoin-bank-crypto-fort-knox-relocates-zurich>

²¹⁹ Barclays is experimenting with bitcoin's blockchain

<http://www.businessinsider.in/Barclays-is-experimenting-with-bitcoins-blockchain/articleshow/47782769.cms>

²²⁰ Greeks are rushing to Bitcoin

<http://money.cnn.com/2015/06/29/technology/greece-bitcoin/>

trades from Greece shot up 79% in June end 2015 from their ten-week average on Bitstamp, the world's third-largest exchange.

28. At the MIT (Massachusetts Institute of Technology) Bitcoin Expo Day 2, Bitpay²²¹ representative confirmed that the company has over 60,000 merchant's signed up which are growing at a 1000 a week in adoption rates. The moto for the company is to decentralize everything starting with digital wallet and payment systems.

29. In August, 2015 the first ever bitcoin exchange in Iran²²² opened. BTXCapital is looking to tap into the 46 million internet users while hoping that bitcoin paves a way for Iran to smoothen ties with the West as well.

30. Indian Reserve Bank of India representative²²³ publicly denounced bitcoin possibility into supporting money laundering, tax evasion and terrorist activities. The authority plans to play a wait and watch game while acknowledging its benefits in financial inclusion as well.

31. Commonwealth's Virtual Currencies Working Group²²⁴ during a three day conference suggested that the common wealth nations should actively consider regulating bitcoins and accommodate it in their legislatures. After hearing from the academia, banking sector and virtual currency business operators and users, recommendations were put forward to the government.

32. In September, 2015 the chief economist at the Bank of England– Andy Haldane²²⁵ proposed the idea of a state sponsored digital currency while addressing a gathering of business owners. The rationale was reduced operational and maintenance costs while the possibility of aligning with the open source digital currency was not mentioned.

33. Abra²²⁶, a remittance service built on top of bitcoin raised \$12 million in Series A funding. Investors in the round include Arbor Ventures, RRE Ventures, and First Round Capital. The total funding to date by the company now totals \$14 million. Unlike other remittance firms, the company does not touch the funds and hence does not deal with any regulatory issues of money transmitter laws.

34. The Commodities and Futures Trading Commission (CFTC)²²⁷ in the US settled charges against business Coinflip for operating an exchange that sold bitcoin options without following appropriate regulations. "In this order, the CFTC for the first time finds that Bitcoin and other virtual currencies are properly defined as commodities," the press release said. Hence, the apex commission publically gave it the status of a commodity not currency for its purposes.

²²¹ Day 2: Technical Sessions, speaker no. 5: MIT Bitcoin Expo 2015 Day 2:

https://www.youtube.com/watch?v=96ULIHhia_Q

²²² Iran's first bitcoin exchange opens in effort to exploit 'huge untapped market': <http://www.ibtimes.co.uk/irans-first-bitcoin-exchange-opens-effort-exploit-huge-untapped-market-1517300>

²²³ Indian Central Bankers Go Public With Bitcoin Views: <http://www.coindesk.com/indian-central-bankers-go-public-with-bitcoin-views/>

²²⁴ Commonwealth Governments Urged to Regulate Bitcoin: <http://www.coindesk.com/commonwealth-governments-urged-to-regulate-bitcoin/>

²²⁵ Thrash Cash, Adopt Bitcoin – a Policy for the Bank of England: <http://www.newsbtc.com/2015/09/19/thrash-cash-adopt-bitcoin-a-policy-for-the-bank-of-england/>

²²⁶ Abra Raises \$12M In Series A Funding For Its Bitcoin-Based Remittance Service:

<http://techcrunch.com/2015/09/10/abra-raises-12m-in-series-a-funding-for-its-bitcoin-based-remittance-service/>

²²⁷ U.S. government is calling bitcoin anything but a currency: <http://fortune.com/2015/09/18/bitcoin-currency/>

35. Bitcoin startup 21²²⁸ revealed their new computer system which allows you to buy and sell goods by mining bitcoin on a low-power computer chip. Through bitcoins generated by the inbuilt mining system, micropayments help connect to any service and pay as you go. Centralized bitcoin mining has reported environmental and profit issues with systemic risks. This could offer an interesting solution while addressing the advertising and digital piracy problem.

36. Elaborate usage of bitcoin by ISIS (terrorist organization) was reported with its American teenage teacher sentenced to 11 years in prison in Virginia state for aiding a terrorist organization. The seventeen year old Ali Amin²²⁹ wrote "Bitcoin and the Charity of Violent Physical Struggle" positioning it as an alternative currency for "Islamic State" after critiquing the use of foreign money as a means of exchange. The essay mentioned the utility of private donations which constitute one of the main sources of revenue for ISIS . This being already used for transferring some donations was mentioned as a way to minimize detection.

²²⁸ 21 Announces The Bitcoin Computer, A Mini-Mining Machine Coupled With A Payment System:
<http://techcrunch.com/2015/09/21/21-announces-the-bitcoin-computer-a-mini-mining-machine-coupled-with-a-payment-system/>

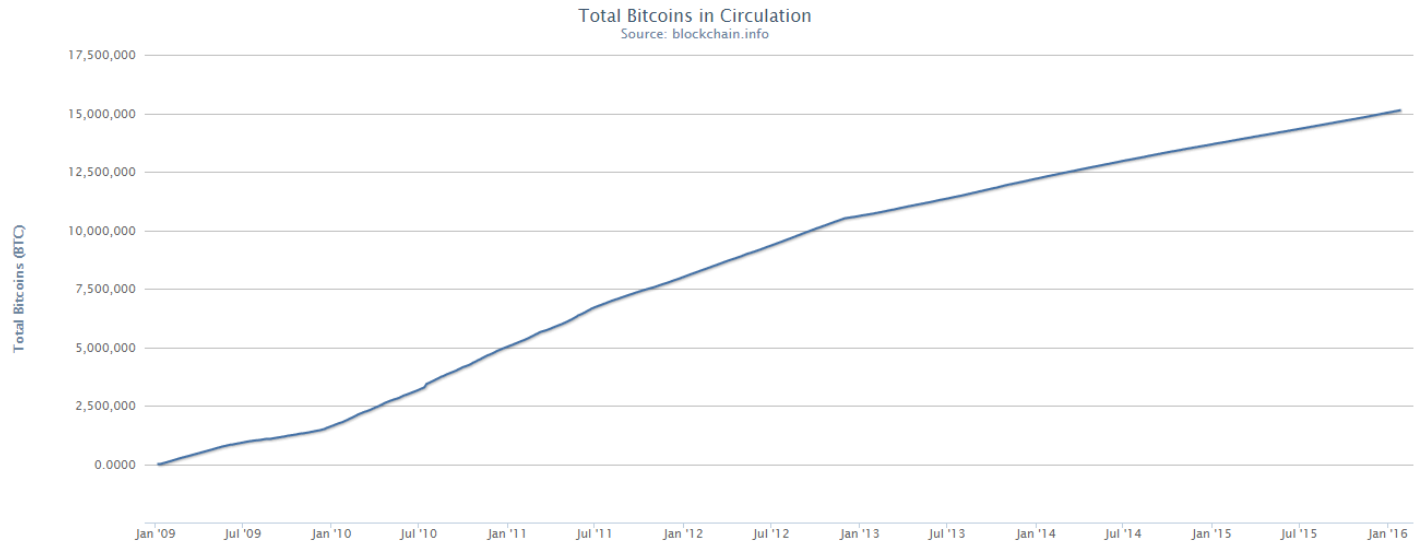
²²⁹ Bitcoin: Islamic State's online currency venture: <http://www.dw.com/en/bitcoin-islamic-states-online-currency-venture/a-18724856>

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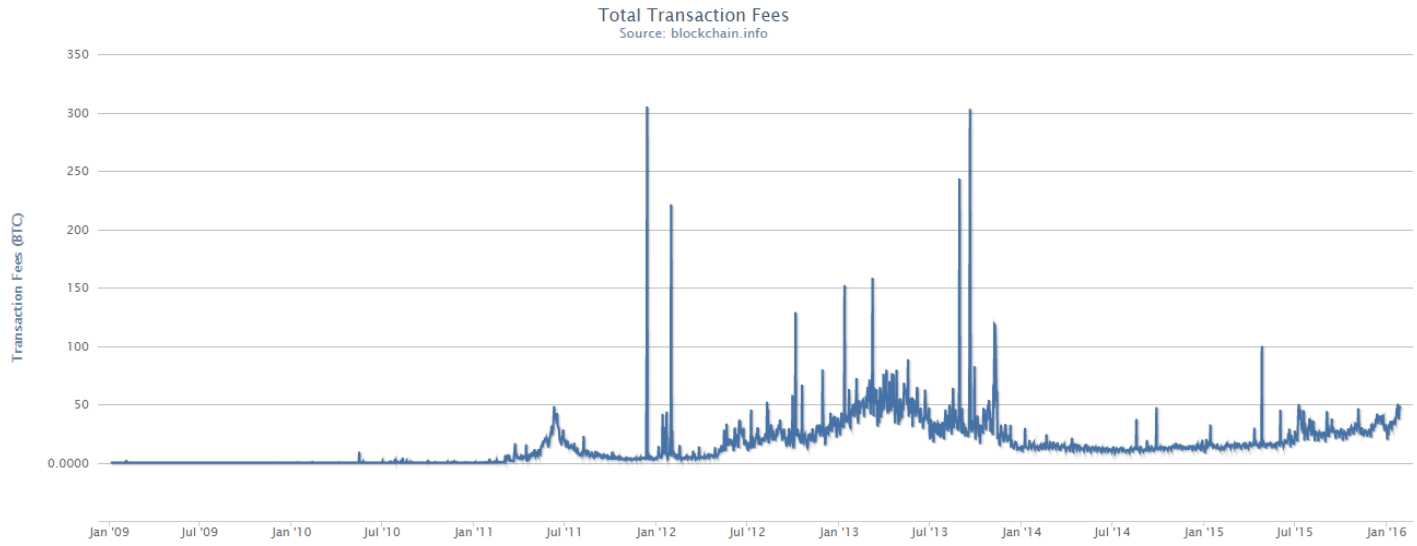
1. Total Bitcoins in Circulation



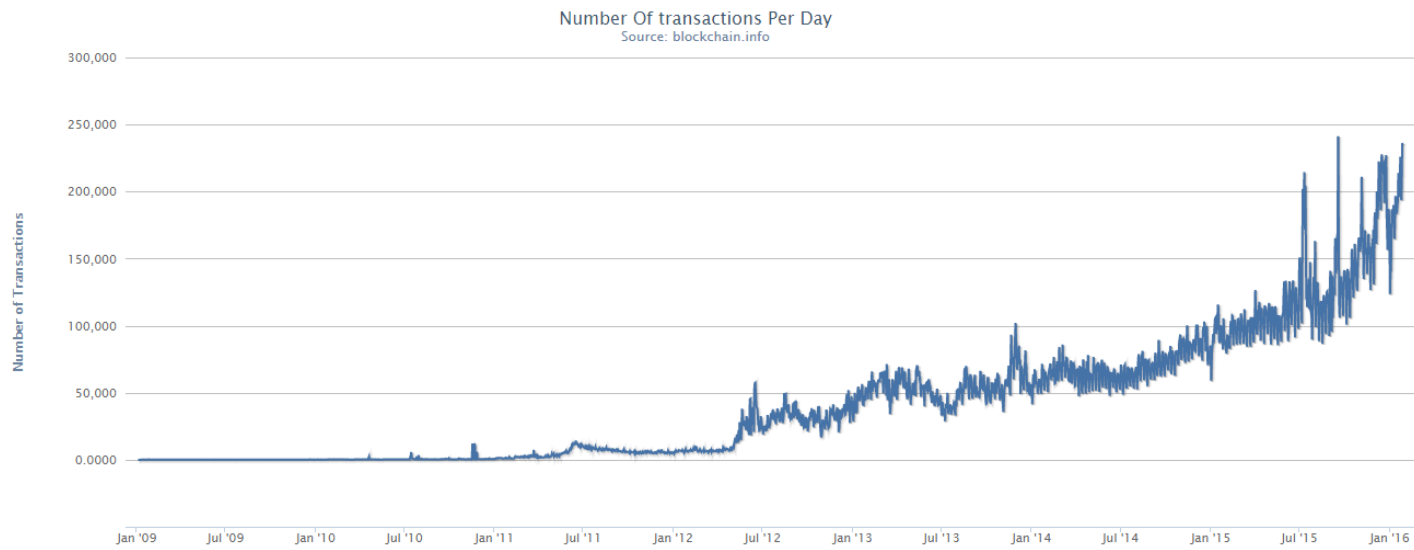
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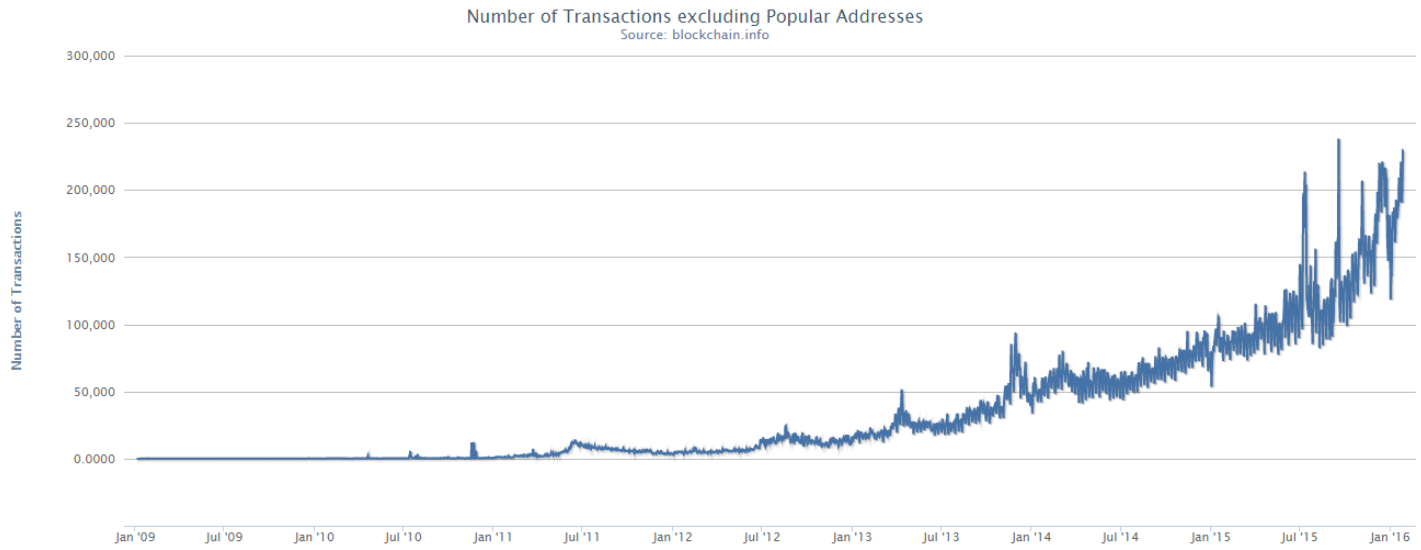
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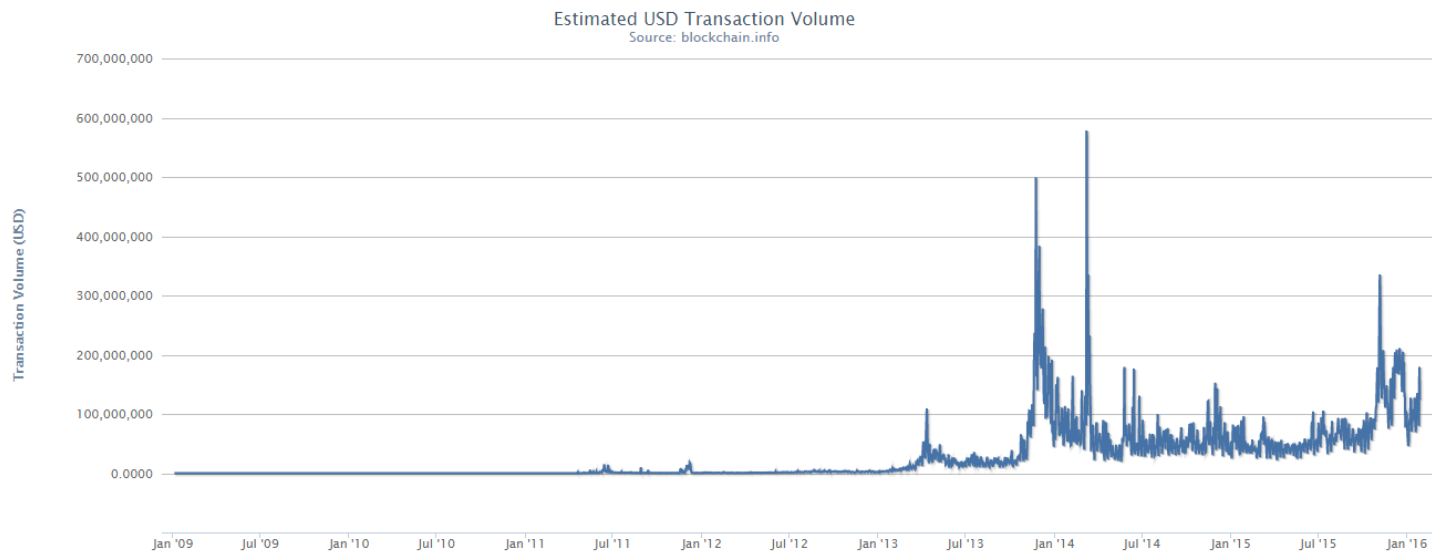
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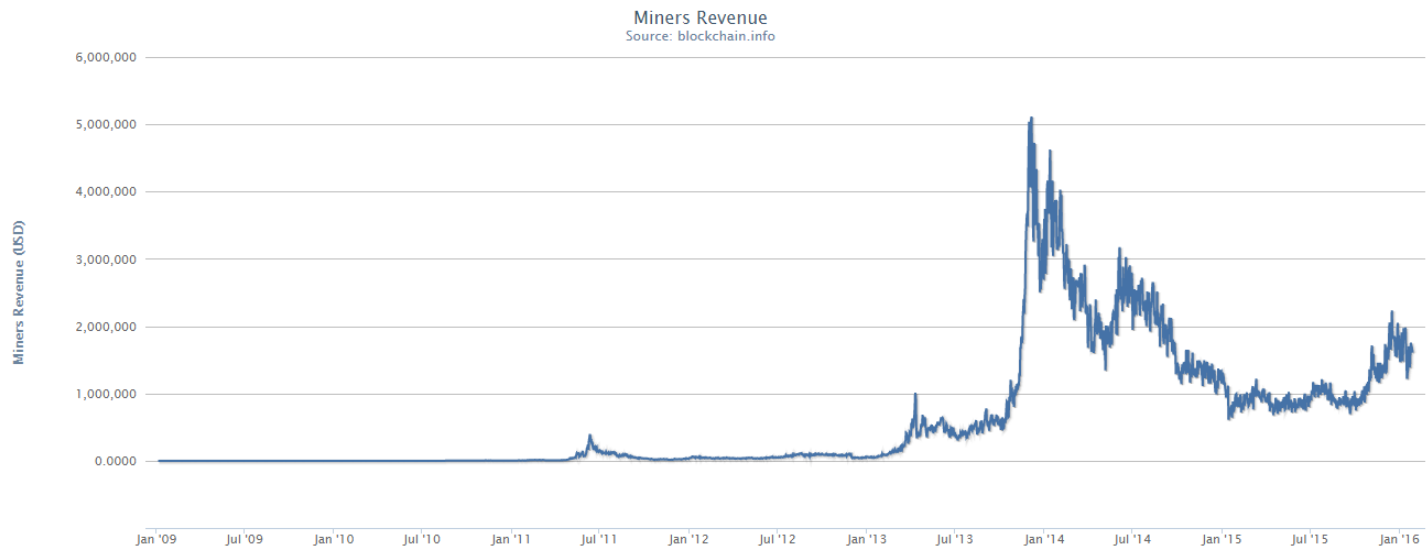
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7. Market Price (USD: US Dollar)



8. Miners Revenue (USD: US Dollar)



9. Hash Rate (Gh/s: Gigahash per second) [Reference for Computing Power Used]

