T. C.

MARMARA ÜNİVERSİTESİ

SOSYAL BİLİMLER ENSTİTÜSÜ

İŞLETME (İNGİLİZCE) ANABİLİM DALI

MUHASEBE – FİNANSMAN (İNGİLİZCE) BİLİM DALI

# BITCOIN AS A CRYPTOCURRENCY AND ITS RELATIONSHIP WITH GOLD, CRUDE OIL AND EURO EXCHANGE RATE

Yüksek Lisans Tezi

NARMIN AGHALIBAYLI

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NARMIN AGHALIBAYLI

Danışman: PROF. DR.JALE ORAN

Istanbul, 2019

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SOSYAL BİLİMLER ENSTİTÜSÜ MÜDÜRLÜĞÜ

# TEZ ONAY BELGESİ

İŞLETME (İNGİLİZCE) Anabilim Dalı MUHASEBE FİNANSMAN (İNGİLİZCE) Bilim Dalı TEZLİ YÜKSEK LİSANS öğrencisi NARMİN AGHALİBAYLİ'nın BITCOIN AS A CRYPTOCURRENCY AND ITS RELATIONSHIP WITH GOLD, CRUDE OIL AND EURO EXCHANGE RATE adlı tez çalışması, Enstitümüz Yönetim Kurulunun 8.08.2019 tarih ve 2019-25/6 sayılı kararıyla oluşturulan jüri tarafından ~~oy birliği~~ / oy çokluğu ile Yüksek Lisans Tezi olarak kabul edilmiştir.

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## ÖZET

### BİR KRİPTO PARA BİRİMİ OLARAK BİTCOİN VE BİTCOİN'İN ALTIN, HAM PETROL VE EURO İLE EKONOMETRİK İLİŞKİSİ


*Bitcoin şifreli, elektronik bir paradır. Ulusal banka veya tek bir gözetmen olmadan başka bir faktöre gerek kalmaksızın dağıtılmış bir defter üzerinden müşteriden müşteriye gönderilebilen ve merkezi olmayan bir dijital para birimidir. Bu incelemede Ham Petrol, Euro/Dolar kurunun ve Altın'ın Bitcoin üzerindeki etkisi incelenmiştir. Gelişmiş para standartlarını ve kriptografik para formlarını yönlendiren genel fikir kullanılmış ve ayrıca diğer temel dijital para standartlarının bir kısmı değerlendirilmiştir. 2016-2018 dönemine ait 151 haftalık veriler baz alınarak Bitcoin ile Altın, Ham Petrol ve Avro'nun ilişkisini incelemek amacıyla Vektör Otoregresif Modeli kullanılmış ve Granger nedensellik testi ile de değişkenler arasındaki ilişkinin yönü tespit edilmiştir. Yapılan analiz sonucunda Bitcoin'in hem petrol fiyatı hem de altın fiyatı değişkenlerinden etkilendiği, her iki değişkendeki fiyat artışlarının da Bitcoin fiyatlarında artışa neden olduğu tespit edilmiştir.*

## GENERAL KNOWLEDGE


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## ABSTRACT

### BITCOIN AS A CRYPTOCURRENCY AND ITS RELATIONSHIP WITH GOLD, CRUDE OIL AND EURO EXCHANGE RATE


*Bitcoin is cryptographic, electronic money. It is a decentralized digital currency without a national bank or a single overseer that can be sent from client to client on the distributed ledger, arranged without the requirement for another factor. In this examination, Crude Oil, Euro/Dollar exchange rate and Gold's impact on Bitcoin has been studied. The general idea driving advanced monetary standards and cryptographic forms of money has been used, and also a portion of the other essential digital monetary standards has been assessed. The Vector Autoregressive Model was used to investigate the relationship between Bitcoin and Gold, Crude Oil and Euro/Dollar exchange rate based on 151-week data of 2016-2018 period, and the direction of the relationship between the variables was determined by Granger causality test. The findings of the analysis show that Bitcoin was affected by both Crude Oil Price and Gold Price variables, and price increases in both variables cause increase in Bitcoin prices.*

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| ***US*** | United States |
| ***USD*** | United States Dollars |
| ***CPU*** | A Central Processing Unit |
| ***VAT*** | Value Added Tax |
| ***BTC*** | The Unit Of Account For The Bitcoin |
| ***P2P*** | Peer-To-Peer |
| ***XRP*** | Cryptocurrency With Ripple |
| ***M-Pesa*** | M For Mobile, Pesa Is For Money In Swahili |
| ***ERS*** | Elliott, Rothenberg and Stock |
| ***ADF*** | Augmented Dickey–Fuller Test |
| ***LR*** | Likelihood Ratio |
| ***FPE*** | Final prediction error |
| ***AIC*** | Akaike information criterion |
| ***SC*** | Schwarz information criterion |
| ***HQ*** | Hannan-Quinn information criterion |

## INTRODUCTION

The medium for exchange is the basic definition of money. Its value is based on the power (politic, economic, military etc.) of the authority who has the prerogative right to impact that particular currency and the perception of that power and faith to the authority publicly as well. The concept of money evolved from bartering livestock and grain to recording its value digitally as "zeroes" in our mobile phones and computers. Although money has been represented in so many forms from seashells, to Fijian whales' teeth and from stones to metal coins, the most common form of money is paper, which became widespread in the American Civil war in the 18$^{th}$ century. In modern days, physical form and representation of money have evolved such unprecedented forms as never seen before in history. Even if it could be stored *in silica*, virtually in modern days, it can still be withdrawn and hold physically in the form of a metal or paper on demand until the cryptocurrencies emerged and started to be accepted publicly as a medium to exchange goods. The word cryptocurrency itself is of modern day concept and it conveys the idea of transferring assets in the digital form and can be referred to electronic money in the literature as well.

The concept of electronic money can be misleading and can be confused with digital banking. The current digital banking system to store and transfer money is an electronic version of these operations based on real currencies which are held in bank accounts. This electronic system is used simply for the ease of circulating real money. Modern banking is based on central banking and fractional reserve system in which a ratio of the digital money deposited is backed by printed currency by holding that fractional reserve in the central banks. Fractional reserve system can be referred to a leverage used by banks to increase profits with the limited amount of deposits held in a particular bank. By this way, the banking system can create digital money and make loans equal to the multiplications of that reserve money.

Electronic money or cryptocurrency is a digital currency which does not depend on a "central bank" (decentralised) or a physical token or paper but based on an open source cryptographic techniques represented by block chain data structure. Bitcoin is the first digital currency of the world invented with the purpose of competing on the market with central banks which are responsible for issuing real currency. The concept of Bitcoin was introduced to the

market in 2008 by a person or group of people bearing the name Satoshi Nakamoto, who according to others is not his true name, thereby making the pioneer of Bitcoin anonymous. In any case, the identity of the pioneer of Bitcoin is of less consequence and importance, what matters is how Bitcoin has impacted the global market in particular and the whole world in general. It is a peer to peer payment system and all the operations on this system can be based on either newly mined Bitcoins or existing coins traded between users. It is the digital and public records of transactions in a cryptocurrency system ordered chronologically Each block stores the information of every transaction of Bitcoins starting from the time it has generated-aka mined. The operations based on the open source software make it reliable because the potentially hidden operations are eliminated in such systems. Put in other words, Bitcoin is a peer-to-peer payment network with no governmental intervention or tracking system. To issue a new Bitcoin to the system, one of the users should "mine" it and introduce it to the system.

The essence of the introduction of the Bitcoin was to enable network member to transfer the money value between themselves directly without involving a third party like a Central Bank or a clearing house as is the case in most money value transfer.[1] With the increased rate of Bitcoin circulation due to its approval in the market by several companies, different sections of the society, as well as the market itself, have started putting forth arguments regarding Bitcoins such as academic papers, debates or TV programs, that are tackling a different aspect of Bitcoins.

Following the dramatic increase in public attention to Bitcoin, central banks, international investors and stock markets are facing a new type of challenge. It has been realized that the conventional instruments to regulate currencies such as political interest rates, reserve option mechanisms, etc. do not apply to this next generation currency. As it has been encrypted digitally by an open source software and limits access of third parties for the regulation of the currency the governments were forced to find next generation regulatory rules to gain control on digital currencies. Another debate has been aroused on the definition of digital currencies whether they are a "currency" or not because of the confusion on the regulatory issues.

[1] Max Raskin and David Yermack," Digital Currencies, Decentralized Ledgers, And The Future Of Central Banking", *National Bureau Of Economic Research*, 2016, No. w22238, https://www.nber.org/papers/w22238 (2 September 2018), p.1.

Before tackling the topic "assessment of Bitcoin as a currency and investment", it should be stated that cryptocurrency has emerged on the market more recently, the authors started putting more effort on Cryptocurrency after the mid-80s. Therefore, the literature on this topic is rather limited[2]. Cryptocurrencies fall under the category of virtual currencies whose definition is given by the European Central Bank as "being a type of unregulated, digital money, which is issued and usually controlled by its developers, and used and accepted among the members of a specific virtual community".[3] Cryptocurrency is described as a system that uses cryptography in a distributed and decentralized way to enable safe transfer and exchange of digital tokens.[4]

This study is an attempt to make a critical analysis of "electronic money" as a currency and its potential as a new instrument for the investors while paying attention to its effect to the market from the statistical and econometrical point of view by taking Bitcoin as its special subject under the cryptocurrency concept. During this attempt, this study introduces and different types of crypto and traditional currencies. This study is expected to shed light on the historical development of Bitcoin starting from its invention as a concept to its acceptance as a commodity and payment method while sharing detailed analysis about the factors influencing its rapid growth and fluctuations in its market price. The study also targets to provide a detailed analysis of whether Bitcoin could operate as a currency, the channels to access Bitcoin as well as the influences of Bitcoin to the market. In doing so, it lists the advantages and disadvantages of bitcoin.

Under the econometrical analysis part, the study focuses on how Bitcoin has operated since its popular acceptance (January 2016 to December 2018) as a payment method and currency with particular attention being paid to the Bitcoin market price. In this part, a detailed analysis of Bitcoin is shared while comparing Bitcoin and US Dollar ($) market prices. Further analysis of Bitcoin mining transactions, as well as the comparison on the market prices of Bitcoin, Crude Oil per barrel ($), Euro/Dollar exchange rate and Gold per ounce ($) for the

[2] Glaser Florian, et al., "Bitcoin-asset or currency? Revealing users' hidden intentions", Twenty Second European Conference on Information Systems, Tel Aviv, 15 April 2014, p.10.
[3] European Central Bank, Virtual Currency Schemes, 2012, https://www.ecb.europa.eu/pub/pdf/other/virtualcurrencyschemes201210en.pdf (2 September 2018), p.13.
[4] The New Palgrave Dictionary of Economics, "Cryptocurrency", New York: Macmillan, 2014, p. 1. https://coincenter.org/wp-content/uploads/2015/05/cryptocurrency-article.pdf (3 September 2018)

same period, will be the subject of this part. The findings of the VAR analysis and Granger Causality Test suggest that gold price and crude oil price have significant effect on Bitcoin prices. According to the results, any increase in these two commodities will cause increase in Bitcoin prices in the coming weeks.

By tackling this area of investigation, this study will be able to bring benefit to investors, financers and financial institutions, academicians, and the general public. It would benefit investors and financier institutions by presenting the performance of the Bitcoin in the market and by identifying the factors that have caused its growth and popularity rapidly. The academicians will benefit from the detailed historical background of Bitcoin as well as other academic aspects that will be presented in the study.

The other significance of this study is that it will be a guideline and illuminate those who desire to invest in Bitcoin. Since Bitcoin has reported such a huge increase in its market price, a lot of people will flock to it or at least planning to invest in Bitcoin. This study will act as a guideline to such people as it will help them to predict changes in Bitcoin prices.

# I. CURRENCY

## 1.1. Brief History of Money

Before tackling different aspects of Bitcoin, there is a need to understand the basic concept of money and currency. Apart from many definitions and concepts in different areas, in economics, money is defined as an asset or commodity that functions as a medium of exchange or a unit of account that can be used to buy any kind of goods and services.[5] Money, in a general concept, should be understood as a social instrument that people use as a medium of exchange or payment.

Currency, on the other hand, is a generally accepted form of money to store value, measure value and facilitate transactions that is circulated within an economy. Money, payment or currency are all socially constructed norms.[6] Our understanding of money should not be limited to what we know today as money or currency, that is to say, bank notes and tokens that exist in many different forms.[7] Almost any object or material can be identified as money in a particular society as long as it performs necessary functions.[8] Throughout history, a variety of things have been used as a medium of exchange, i.e shells, gold, silver, cattle, rum, etc. For example, cowrie, the shell of mollusca found in shallow parts of Indian and Pacific Oceans, have been used over centuries for a quite a long time as a primitive money and then spread to other parts of the planet.[9]

On the other hand, much more specific and geographically limited objects compared to cowrie, having a vast variety, have been used as money. Such examples are the sperm whale's tooth (tambua) that is found in Fijian group of islands and unique stone currency (Rai) of Yap, a cluster of small islands in the central Pacific. Rai, for instance, was used as money as recently as the mid-1960s. Some of the early colonist of North America used maize and wheat as a legal tender due to the shortage of coin. Oddly enough, within the indigenous communities, white

[5] Christian Groth,"Lecture Notes in Macroeconomics" ,2015, Unv. Of Copenhagen, Dep. Of Economic, http://web.econ.ku.dk/okocg/VM/VM-general/Material/Chapters-VM.htm (1 October 2018)
[6] Rhys Bollen, "The legal status of online currencies: are Bitcoins the future?", *Journal of Banking and Finance Law and Practice*, 2013 , https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2285247 (5 October 2018) ,p.1
[7] Susan Mettes, "Wait, What is Money ", *Christianity Today*, 2017, Vol. 61 No. 1, p. 2.
[8] Bollen, 2016, p. 1.
[9] Glyn Davies, A History of Money from Ancient Times to Present Day, Cardiff: 2002, p. 36.

strings of beads, referred to locally as 'wampumpeag', were the most accepted and widespread currency in those areas.[9]Another interesting example as a currency form is cattle. Cattle, in definition a common term referring to meaning cows, buffalo, goats, sheep and camels, was a form of currency in some parts of the world and is still used in some regions of Africa as means of payment for blood money, bride money or dowry.[9] The system based on trading goods or services for another is named as barter system. In the barter system people would involve a two-sided coincidence of demands. It is a condition in which two side should demand the commodities or services which the other side can supply. There is a need for a medium for exchange of goods and storing the value and labor in complex modern economy in which thousands of services and goods are traded, thus Barter system is not applicable and "money" is necessary. The borders and differences between cultures and economies of the countries created the differences in the value of the money in different parts of the worlds and this emerged a need for "currency". In modern times, currency has been generally clustered in two categories depending on the geographical use of the currency, namely domestic and foreign currencies. Domestic currency of a particular region is the currency which is issued as a legal tender in a particular country or a group of countries, whereas foreign currency is all other not issued as legal tender in that particular area.[10]

### 1.2. Functions of Money in an Economy

For money to be considered as important aspect of life, as is regarded by many, it has to perform certain functions in their day to day life particularly in the economy of a particular country of society. The economy serves as a vehicle for fulfilling the needs of people to survive. The economy should fulfill the needs of people by making it possible for goods and services to be provided constantly at reasonable and stable values. In the barter system, the payment for a service can be made with another service or good but for example what if a worker do not need any services or goods at the pay day. What could be the best way and satisfy the service provider in such cases? Can he store the goods he get as payment for a long period? The goods and

[10] IMF Committee on Balance Of Payments Statistics, Definition of Domestic and Foreign Currency, 2004, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.448.6566&rep=rep1&type=pdf (10 October 2018), p.1.

services needed to be exchanged within the people who demands those goods and services, this is where money comes in.

Basically, money functions a solution for the barter system because it creates a platform between the buyer and the seller without a need for mutual demand. In the economy, money acts as a "medium" which common prices for the goods and services can be pegged as well as the payment of services being standardized. This is important because it helps drive the economy to prosperity as providers of goods and services have a clear picture of how much money they will earn by providing particular goods and services in the economy.

The other importance of the function of money in an economy is that it is a "unit of account" so that makes easy for people to produce goods and provide services at different prices based on their properties in the market. This issue convinces people to accept a particular commodity as tender.

The other importance of the functions of money in economy is that it can be stored for future purposes. Despite that there is a probability of money to lose its value due to the inflation, the devaluation of a good is more probable than money itself. To protect their earnings from devaluation or from being rotten in a hatch people would have been obliged to spend all their earnings by the fear of it losing its value. However money make it possible to "store" the earnings easily and let people to spend whenever it is necessary. When we sum up, money functions as a medium for exchange, a unit for account and it is an easy way to store earnings. These there are very important for a modern economy to be built up.

### 1.2.1. Money as a Medium of Exchange

The first function of money in an economy is that it acts as a medium of exchange.[11] In the past trade was carried out by means of Barter which allowed people to exchange one commodity against another. It was an adequate system when there were a limited number of goods and services even though it has some drawbacks such as transportation problem,

[11] Peter Groenewegen, "The Nature, Function and Value of Money: a Brief Exposition of Turgot's Moneyary Theory", *History of Political Economy*, 2007, Vol. 39, No 2, https://econpapers.repec.org/article/hophopeec/v_3a39_3ay_3a2007_3ai_3a2_3ap_3a253-262.htm (12 October 2018), p.255.

difficulty in deferred payments or installments, necessity in double coincidence of wants and not being able to store the wealth easily. These limitations emerged the necessity for a common good, commodity or a unit to exchange goods and fix the prices. It should have some properties to be accepted as a medium for exchange. It should be defined and processed easily with available technology, should be inert so that it would not corrupt or rotten, should be stored and collected easily and finally it should be rare enough not to be abused by the community. Gold is one of those materials that is possess those properties, thus it is used as an alternative exchange since ancient times. Within hundreds of years it proved itself as an alternative to exchange goods and people stopped using Barter for the exchange of goods and services, instead they started to trade with an item which all of them were willing to accept as payment. In this way, money in the form of gold, silver or some other precious alloys helped the economy by simplifying the transactions as well as bringing organization to the economy.[12] Hence it is in this way that money functions as a medium of exchange.

### 1.2.2 Money as a Measure of Unit

The second function of money in an economy is that it is a measure of value.[13] This means that money has been used as a common standard to measure and compare the prices of goods and services. Whatever transaction that people want to conduct are done by reducing the payment to simple monetary units where all of the parties are able to understand.[14] As an example, if a person was desirous of purchasing a vehicle in the modern times, he would have to think of how much money he has to spend in dollars or any other currency. If money were not a measure of value then the person wanting to buy a car would have to think of how much cattle, maize, wheat or any other commodities would he need to exchange in order to get the vehicle. Thus it is a way for the standardization of the prices and let people trade by trusting each other in the economic system.

[12] Gary Rabbior, Canadian Foundation for Economic Education, 1994, https://static1.squarespace.com/static/5a2f0006f9a61e8b0732c355/t/5bad0ed353450aacfde9c97d/1538068180233/MoneyMon.Pol.Cda-Module_8.pdf (16 October 2018), p.6.
[13] Groenewegen, p. 255.
[14] Rabbior, p. 6.

### 1.2.3 Money as a Store of Value

The third function of money in an economy is that it functions as a store of value.[15] This means that money can be used to save our wealth for future use to buy things and make immediate payments at any time. For instance, if a person had tomatoes and he wanted to keep them for future payment he would fail to do so simply because after a short period its value will have disappeared due to the fact that it does not store value as it can rot away within time. This is what makes money unique from many other commodities.

## 1.3 Money as Currency

The term currency comes from the word "curraunt" which means "in circulation" in old English. In the modern economy it refers to any form of "money" which can be accepted in trading goods and services[16]. Money circulates in the economy as banknotes, coins, digital numbers or cryptocurrencies. The value of each currency in the market can be converted to each other and the value is determined basically depending on the authority issuing that currency. After the civilizations stopped barter system the economy mainly depends exchange commodities from several metal, alloys, seeds or even salt which have their intrinsic values. Economy based on commodity currencies is similar to the barter system but there are a couple of publicly accepted currencies (commodities) in this system. This progress solved the measuring and pricing problem in the barter system but the storage of the wealth problem still exists in such an economy. Using precious metals like gold, silver, copper as commodity money partly solved the storage problem partly but these metals are rare and the abundance of these metals could not fulfill the monetary needs of the growing economy. This shortage was solved with the commodity-backed monetary system. In this monetary system central banks issue their currencies as the representation of a physical commodity at a fixed rate as a standard which is mostly gold or silver thus this monetary system is named as representative money as well. People who own that currency can exchange that it with the real backed commodity whenever they want. The commodity-backed money partly solved the money supply problem but central banks still cannot issue money freely even if there is a demand in the liquidity in the economy. Fixing a currency to a relatively stable priced commodity prevents debasement of the currency by limiting money supply which in turn causes increasing the prices of the assets speculatively

[15] Groenewegen, p. 255.
[16] *Definition of currency,* 2018, https://www.merriam-webster.com/dictionary/currency (20 October 2018).

when there is a huge expansion in credits. When the asset bubbles bursts, the economy crashes and demand decrease which causes regression as it happened in 1929 in the United States. Even though the commodity-backed currencies value is relatively stable there are still some volatilities based on the changes in the values of the commodities backing that currency based on speculations and the financial actions of companies which are producing that commodity (like gold miners). These drawbacks force the governments to change the monetary system to "fiat currency" in which the value of the currency does not depend on a commodity but the economic power and reliability of the governments.

### 1.3.1. Fiat Currency

The word "fiat" comes from the Latin, meaning "let it be done". Fiat currencies has no intrinsic value but their value comes from the trust to the governments. The United States Dollars carries a statement that "This note is legal tender for all debts, public and private." Which means "by government decree, if you owe a debt, you can pay that debt with that paper, even though that paper does not have an intrinsic value. The central banks or the governments issue fiat currencies by legal regulations on demand without any need to be backed by gold or any other commodity[17]. Because the papers value is much more less than the amount written on it, the governments prints this currency on combined materials which are difficult to reproduce with ordinary printing technologies to control counterfeiting and maintain the stability of its value in the economy. The first form of money that exists in the modern day economy is real money.

### 1.3.2. Credit Money

The other form of money which is in circulation in the economy is Credit money. Credit money is *bank deposits which have replaced central banknotes as a result of development of the banking system led by a central bank*.[18] Credit money has its origin from the fact that money functions as a means of making payments. With regards to this type of money, goods are sold against a promise to pay (trade bills) rather than paying money

[17] Mack Ott and John, A Tatom, "Government Finance and the Demand for Money—the Relation between Taxation and the Acceptability of Fiat Money", *Economic Notes*, 2016, Vol. 45 No 1, https://onlinelibrary.wiley.com/doi/abs/10.1111/ecno.12048 (20 October 2018), p. 56.
[18] Claus M. Germer, "Credit Money and Functions of Money in Capitalism", *International Journal of Political Economy*, 1997, Vol. 27, No. 1, https://ec.europa.eu/jrc/en/publication/digital-agenda-virtual-currencies-can-bitcoin-become-global-currency (21 October 2018), p. 44.

immediately.[19] Hence in this case trade bills carry the functions of money as a means of payment.

### 1.3.3. Digital Currency

The other form of currency that is circulating in the economy is digital currency. This type of currency uses a computer bases system to create and share the economic value of the money.[20] The unique characteristic of this type of currency is that it enables its users to participate directly in the transaction without the intervention of third parties like banks.[21]

Digital currency is very much similar in its functions and characteristics to the real or fiat currency in the sense that it is used as medium of exchange, it functions as a unit of measure of account and it is also used to store value.[22] In addition, digital currency does not require recognition as tender in a particular country to operate, it is not limited to jurisdiction as it is not issues by any government or central monetary institutions.[23]

Digital currency is seen as having a digital representation of the fiat currency, that is to say currency that is stored and transferred electronically. This means digital currency can be converted to its equivalent value of fiat or real currency by the owner, it can also be reverted back to its digital form. [24]

Digital currency is not a recent phenomenon, it has been around as far as the mid-1990s. One of the earliest digital currency was E-gold which was established in the year 1996 as well as Liberty Reserve which was established 10 years later in the year 2006. These currencies were similar to modern day digital currency except for the fact that they were backed by gold and they were centralized, features which are, as seen, not associated with the modern day digital currencies.

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[19] Germer, p. 45.
[20] Jeffrey H. Matsuura, Digital Currency: An International Legal and Regulatory Compliance Guide, U.A.E: Bentham Science Publishers, 2016, p. 3.
[21] Matsuura, p. 3.
[22] Steven Stern, "Digital Currency: May Be A 'Bit Player' Now, But In the Longer Term A 'Game Changer' For Tax", *Journal of Australian Taxation*, 2017, Vol. 19, No.1, http://www.jausttax.com.au/Articles_Free/JAT%20Volume%2019%20Issue%201%20-%20Stern.pdf (25 October), p. 7.
[23] Stern, p. 7.
[24] Stern, p. 7.

The widespread use of digital currencies after the recent developments in information technologies folded up the amount of money circulating in the economy for a couple of times which increases the availability of services and assets.

### 1.3.4. Virtual Currency

Virtual currency is the other form of currency that is in circulation. It has to be stated that a lot of authors confuse between virtual and digital currency which results in using them interchangeably. This confusion is understandable since virtual currencies are a type of digital currency, all virtual currencies are recognized as being digital currency however not all digital currencies are virtual currencies.[25]

The definition of virtual currency as provided by the European Central Bank is that is virtual currency is a type of unregulated, digital currency issued and generally controlled by its developers and used and accepted by members of a particular virtual community.[26] From this definition we can clearly see that virtual currency is a form of digital currency. However it varies in some way with other digital currencies in that in virtual currencies the unit of account is changed to a virtual and is no longer such units as dollar or euro as is with other digital currencies.[27]

Virtual currencies are obtained by their owners in two major ways; the first way is for the owner of the virtual currency to purchase it using the traditional money (fiat currency) and thereafter the money that has been paid is converted to the virtual currency at a given conversion rate. Apart from purchasing the virtual currency, a person obtains virtual currency by participating in activities which allows them to increase their stock. These activities can range from promotion, advertisement and mining.[28]

Virtual currencies are mainly categorized into three categories which are based on the interaction of the virtual currency with the economy.

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[25] Andrew Wagner, "Digital vs. Virtual Currencies", *Bitcoin Magazine*, 2014, No. 22, https://bitcoinmagazine.com/articles/digital-vs-virtual-currencies-1408735507/ (10 November 2018).p.1.
[26] European Central Bank, Virtual Currency Schemes, 2012, https://www.ecb.europa.eu (15 November 2018), p. 13.
[27] European Central Bank, Virtual Currency Schemes, 2012, p. 16.
[28] European Central Bank, Virtual Currency Schemes ,2012, p. 13

The first category of virtual currency is called closed virtual currency; this type is associated with online games and it has no association with the economy. The owners pay a particular fee to earn the virtual currency on their online gaming performances. As such, this type of virtual currency is not capable of being used outside the online environment for which it was created to be used, therefore its purchases are limited to those within the realm of the online atmosphere which serves its purpose.[29] Examples of this type of virtual currency is World of Warcraft Gold which is a virtual currency used as a medium of exchange in an online role playing game, which allows players to buy and sell whatever items that are available in the online game.

The second category of the virtual currency is called virtual currency with unidirectional flow. This type is capable of being purchased directly by using the fiat currency at a given exchange rate. However, once it has been purchased there is no way that it can be converted back into fiat currency. This types of currency can be used to purchase items both in the virtual world as well as items in the real world.[30] An example of a virtual currency which falls under this category is Facebook Credits which was established in 2009 and allows the owners to purchase virtual goods which are found in the applications associated with Facebook. The owners of this currency obtain it by either purchasing the currency using the fiat currency or by participating in special advertisement or promotions.

The third type of virtual currency is called virtual currency with bidirectional flow. Under this type of currency, owners purchase the virtual currency by using fiat currency. The owners also sell this currency to others by using fiat currency. Since this type is capable of being converted back and forth, it is therefore capable of being used to purchase items in the real and the virtual world.[31]

Linden Dollars is a virtual currency which falls under this category. This virtual currency is created for the purposes of being used in a virtual world. However, the creators of the currency have also created a platform where the owners of the currency are able to buy and sell items to each other by converting the currency using a given exchange rate.

[29] European Central Bank 2012, Virtual Currency Schemes, p. 13.
[30] European Central Bank 2012, Virtual Currency Schemes, p. 14.
[31] European Central Bank 2012, Virtual Currency Schemes, p. 14.

## II. CRYPTOCURRENCY

As mentioned in the previous part, money exists in different forms and such has always been the case since time immemorial. The advancement in technology has also changed our financial systems particularly our concept of money. Today we have a type of money which could not be perceived at all in the early generations, the cryptocurrency. Cryptocurrency is the new generation money.

The meaning of cryptocurrency as provided by Hegadekatti is that "*A cryptocurrency is a medium of exchange using cryptographic techniques to safeguard transactions and also manage the formation of additional units of the currency*[32]."

Harwick defines the cryptocurrency as;

*"A cryptocurrency is a method of constituting virtual "coins" and providing for their secure ownership and transaction using a cryptographic problem. This problem is designed to be easy to verify but computationally difficult to arrive at a solution. Various cryptocurrencies use different functions for this purpose, the most common being a hash target, by which hashes are calculated so as to come in lower than a certain value. The hash target (i.e., the difficulty of the problem) is adjusted every so often based on the total computing power on the network, which has the advantage of keeping the time between solutions more or less constant."*[33]

Cryptocurrency uses a science called cryptography, which is a method of communication in the presence of adversary such as delay, interception or anything that can change the communication.[34] So in this regards, all digital currencies that are decentralized and use the technology referred to as cryptography fall under the category of cryptocurrencies.[35]

For the transactions of cryptocurrency to be completed the owners of the currency use what is known as a Crypto wallet. The crypto wallet is an encrypted electronic devise which is

[32]Hegadekatti Kartik, Analysis of Contracts in Various Formats of Blockchain, DoPT, 2016, https://ssrn.com/abstract=2890577 (7 December 2018), p .2.
[33] Cameron Harwick, "Cryptocurrency and the Problem of Intermediation", *Independent Review*, 2016, Vol. 20, No. 4, http://www.independent.org/pdf/tir/tir_20_04_05_harwick.pdf (8 December 2018), p. 570.
[34]Campbell R Harvey, "Cryptofinance", 2016, Duke University, Fuqua School of Business, https://ssrn.com/abstract=2438299 (8 December 2018), p.2.
[35] Neil Gandal and Hanna Halaburda, "Competition in the Cryptocurrency Market". Bank of Canada Working Paper 2014-33, Canada, 2014, https://ssrn.com/abstract=2501640 (10 December 2018), p.2.

used for the transaction.[36] The crypto wallet has a public key visible to all, however, it can only be operated by the person who has a private key, and this makes all transactions related to cryptocurrency anonymous.[37]

As it was discussed in the previous parts, the functions of money is defined as a medium of exchange, a measure of the unit and a store of value.[38] It is analyzed within a research that whether Bitcoin can be considered a currency or not.[39] Authors compared the features of Bitcoin against these functions of money. For Bitcoin it is capable to be a medium of exchange it has to serve the purpose which is being able to use used for payment purposes. The researcher found that since many company, vendors and national governments have accepted Bitcoin as a means of payment then it serves this particular purpose of being a medium of exchange.

### 2.1. Emergence and Development of Cryptocurrency

One could assume that cryptocurrencies had been discovered recently by looking at the current popularity of Bitcoin. However, cryptocurrency is a phenomenon which had been argued for more than 30 years even though they did not gain much attention from the public. The idea of cryptocurrency has been discussed hypothetically and academically since 1982 in *Blind Signatures for Untraceable Payments.*[40] In this article the idea of untraceable electronic payments, a secure digital cash system was presented for the first time in the history. The basic idea was that users could withdraw a digital currency from a platform or a bank without being tracked by that platform or any third party.

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[36] Hegadekatti, p. 1.
[37] Hegadekatti, p. 1.
[38] William Stanley Jevons, "Money and the Medium of Exchange", New York, 1876, http://oll.libertyfund.org/titles/jevons-money-and-the-mechanism-of-exchange (15 December 2018), p.14.
[39] Stephanie Lo and J. Christina Wang, "Bitcoin as Money?", *Current Policy Perspectives*,2014, Vol., https://www.bostonfed.org//media/Documents/Workingpapers/PDF/cpp1404.pdf (15 December 2018),p.4.
[40] David Chaum , "Blind Signatures for Untraceable Payments", *Advances in Cryptology Proceedings of Crypto*,1982, http://www.hit.bme.hu/~buttyan/courses/BMEVIHIM219/2009/Chaum.BlindSigForPayment.1982.PDF (16 December 2018)

Chaum founded an electronic money corporation in 1990 called DigiCash to practice his ideas.[41] The mission of the company was to provide an online payment system which ensures the anonymity of the user with blind signatures as stated in the paper. The first electronic cash payment over a public computer network was performed by the company in 1994.[42] Digicash did not succeed to achieve to introduce cryptocurrency, however, it paved way for future endeavors which would be carried out in that field.

With the failure of the implementation of the ideas of Chaum, in 1998 Wei Dai proposed another digital currency which would be anonymous and capable of being distributed and he called it b-money.[43] The b-money would allow "*untraceable pseudonymous entities to cooperate with each other more efficiently, by providing them with a medium of exchange.*"[44] This ideal as well did not materialize practically.

There were also other efforts to create cryptocurrencies, including E-gold which was allowing a person to trade with dollars and it was backed by gold in 1996. However, it was unplugged by the US government by claiming that it is used in financing some criminal activities[45]. Apart from E-gold, there was also Liberty dollar which was established in 2006 as a paper, coin and electronic currency which was backed by gold as well.[46] Once again the project did not succeed and its creators were prosecuted by the US government.

In 2007 an SMS based money transfer system called M-PESA was invented by SafariCom in Kenya. The system made it possible for people to deposit, send and withdraw money by using their phones.[47] The chargers were deducted from the accounts of the users

[41] Waleed Abrar, "Untraceable Electronic Cash with Digicash", Network and Communication Privacy Uni-Konstanz, 2014, https://www.researchgate.net/publication/277598468_Network_and_communication_Privacy_Digi_cash (20 December 2018), p. 1.
[42] Joey Conway, "Beginners Guide to Cryptocurrencies", https://www.joeyconway.com/blog/2014/10/23/cryptocurrency-beginners-guide/ (20 December 2018), p.1.
[43] Reuben Grinberg, "Bitcoin: An Innovative Alternative Digital Currency", *Journal of Hastings Science & Technology Law*, Vol 4, No.1, https://repository.uchastings.edu/hastings_science_technology_law_journal/vol4/iss1/3/ (23 December 2018), p. 162.
[44] Grinberg, p. 162.
[45] Grinberg, p. 161.
[46] Grinberg, p. 161.
[47] William Jack and Tavneet Suri, "Mobile Money: The Economics of M-Pesa", National Bureau of Economic Research Working Paper 16721, 2011, http://www.nber.org/papers/w16721 (23 December 2018), p.6.

when transaction was conducted using e-float, the currency of the M-PESA.[48] According to some academicians, M-PESA is the first private digital currency which acted as a medium of exchange in the real economy.[49]

It was not until 2008 that "Satoshi Nakamoto" finally found a way to implement the cryptocurrency, together with this, he also created a software which would be used in the transactions of the cryptocurrency.[50] This electronic cash system was named as Bitcoin.

### 2.2. Examples of Cryptocurrencies

Due to the popularity of Bitcoin these days, many people may believe that Bitcoin is the only cryptocurrency on the market. However, there are more than 2000 cryptocurrencies on the market. To compare the value of the Bitcoin over the other cases, it is better to compare it with other important cases in the world. For this purpose, it is better to look at Top 100 Cryptocurrencies by Market Capitalization, where it can be seen that Bitcoin is the most important cryptocurrency in several years. Market Cap of Bitcoin have more market cap value than the other 99 cryptocurrencies in the list. As of 30.09.2018, the total market value of all the cryptocurrencies is more than 225 billion US dollars and market value of Bitcoin is almost 115 billion US dollars (50, 8%). [51] Although there are hundreds of cryptocurrencies in the market, a few of them are popular and regarded as the major cryptocurrencies because their market capitalization is much higher than the others. In the following, the cryptocurrencies, which have a market capitalization of more than 1 billion dollars, will be examined.

#### 2.2.1. Litecoin

Litecoin was launched in 2011 to serve as an alternative to Bitcoin. It is less expensive compared to Bitcoin and its algorithm was designed to make it easily accessible to all to use. It is a peer-to-peer cryptocurrency that allows immediate payments of almost zero costs to anyone in the globe.

According to the inventors, the source code of Litecoin is similar to Bitcoin but it can process its blocks four times faster than Bitcoin thus its more resistant to double spending

[48] William, p. 6.
[49] Raskin, p. 4.
[50] Grinberg, p.161.
[51] *Price*, https://coinmarketcap.com , 2018, (25 December 2018).

attack. However, it causes an increase in the occurrence of orphaned blocks that are not accepted into the blockchain network due to be produced by multiple miners simultaneously in the lag period. [52] Unlike Bitcoin, it uses Scrypt algorithm. Litecoin Network is designed to issue 84 million coins which are 4 times more than Bitcoin.[53]

Litecoin is an open source, a complete decentralized global payment network without any central authority. Litecoin offers quicker confirmation times for transactions and better storage efficiency than the leading math-based currency.[54] Moreover, Litecoin is kind of money which is decentralized, free from censorship peer-to-peer Internet currency and open to all. It is better to mention that the Litecoin blockchain is one of the largest global scrypt based network in the world which is operating with 100% uptime. It is securing billions of dollars of value. In comparing with Bitcoin, the aim of the Litecoin Network is to process a block every 2.5 minutes instead of Bitcoin's 10 minutes. It is notable to declare that Litecoin uses proof-of-work, which is a unanimity mechanism that depends on a difficult computational task to assure the network from malicious actors.[55]

In figure 1 Litecoin Price (USD) and Trading Volume in dollars has been illustrated. It is clear that from 2017 until nowadays, Litecoin Price (USD) and Trading Volume have been grown and cause the Litecoin to be one of the important and considerable currencies. On December 2017 is the peak of the curve which means the most usable time of the Litecoins were that time, but after that, it is still keeps its growing in comparing with the latest year.

[52] *Orphan Block (Cryptocurrency)*, 2018 https://www.investopedia.com, (3 January 2019).
[53] Saifedean Ammous, "Can Cryptocurrencies Fulfil the Functions of Money?" 2016, Columbia University, Center on Capitalism and Society, Working Paper No. 92, https://ssrn.com/abstract=2832769 (3 January 2019), p.18.
[54] https://litecoin.org/ , 2018, (10 January 2019).
[55] *"Deep Dive into Litecoin (LTC)",* 2018, https://crushcrypto.com/wp-content/uploads/2018/10/Crush-Crypto-Deep-Dive-Litecoin-LTC.pdf (10 January 2019).

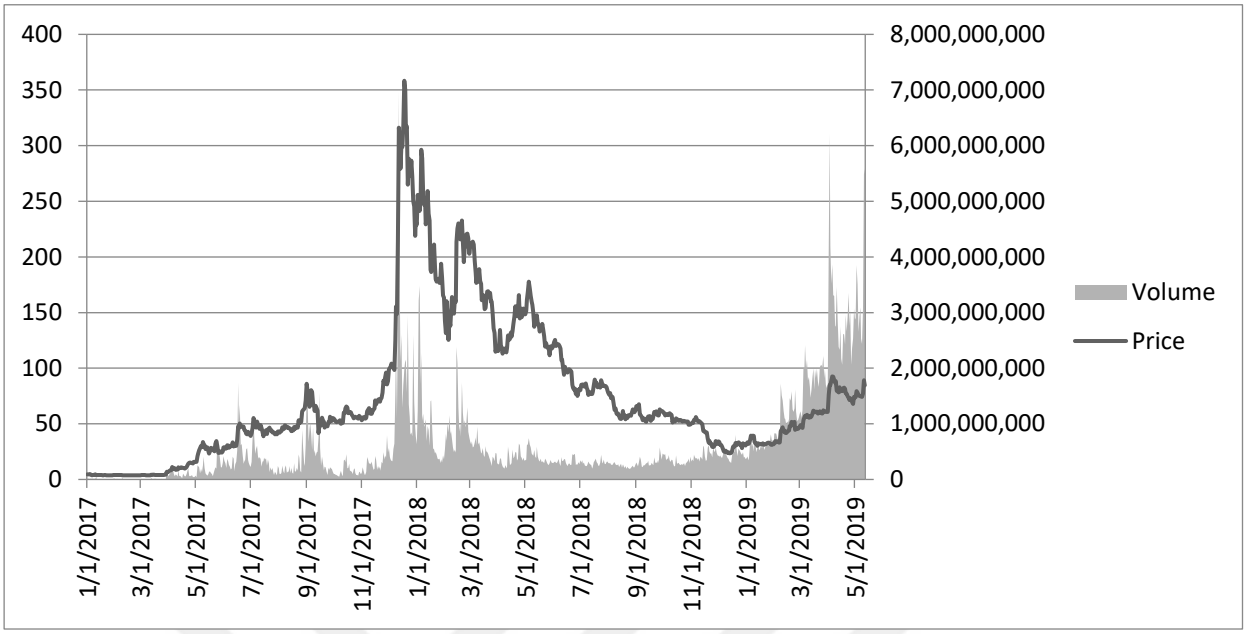


**Figure 1.** Litecoin Price (USD) & Trading Volume

**Source**: https://coinmarketcap.com/currencies/Litecoin(05.04.2019)

### 2.2.2 Ether

According to the total market cap, Ether, which is the symbol powering Ethereum network, is in the first three trading currency with Bitcoin and Ripple (XRP).[56] Ethereum is software based on the blockchain technology. Ethereum is one of the projects that useful for generalization technology where all the transactions-based state machine concepts may be built. State machines store the status of the blocks at a given time with a finite internal memory. It also seeks to provide a tightly integrated end-to-end software building system for the end-developer. It allows developers to generate markets, store registries of debts or promises, move funds with respect to instructions given in the past (such as a will or a future contract) and

[56] *"All Cryptocurrencies",* 2018, https://coinmarketcap.com/all/views/all/ (1 March 2018).

many other things that have not yet been established, all without a middle person or counterparty risk.[57]

Accounts is the state which is made up of objects in Ethereum, where each account having a 20-byte address and state transitions and it is being direct transfers of value and information between accounts. In Ethereum, transaction is used to mention the signed set of data that stores a message to be sent. Transactions in Ethereum includes: reception of the message, identifying the sender, the amount of the transferred ether, field of the optional data. Initially assumed of the Ethereum protocol as an improved version of a cryptocurrency,it supplies developed features such as on-blockchain escrow, withdrawal limits, financial contracts, and gambling markets.[58]

When Ether was created an amount of 60 million ether was granted to the contributors, 12 million were designed to be for the developers of the currency as well as the Ethereum foundation.[59] Ethereum Price (USD) and Trading Volume in dollars also is shown in figure 2. It confirms that in 2017 and 2018 Price and Trading Volume of the Ethereum increased.

[57] https://www.ethereum.org/ (10 March 2019).
[58]Shailak Jani, "An Overview of Ethereum & Its Comparison with Bitcoin". *International Journal of Scientific & Engineering Research*, 2017, Vol.10, No.8, https://www.researchgate.net/publication/323078799_An_Overview_of_Ethereum_Its_Comparison_with_Bitcoin (10 March 2019), p.7.
[59] Ammous, p, 12.

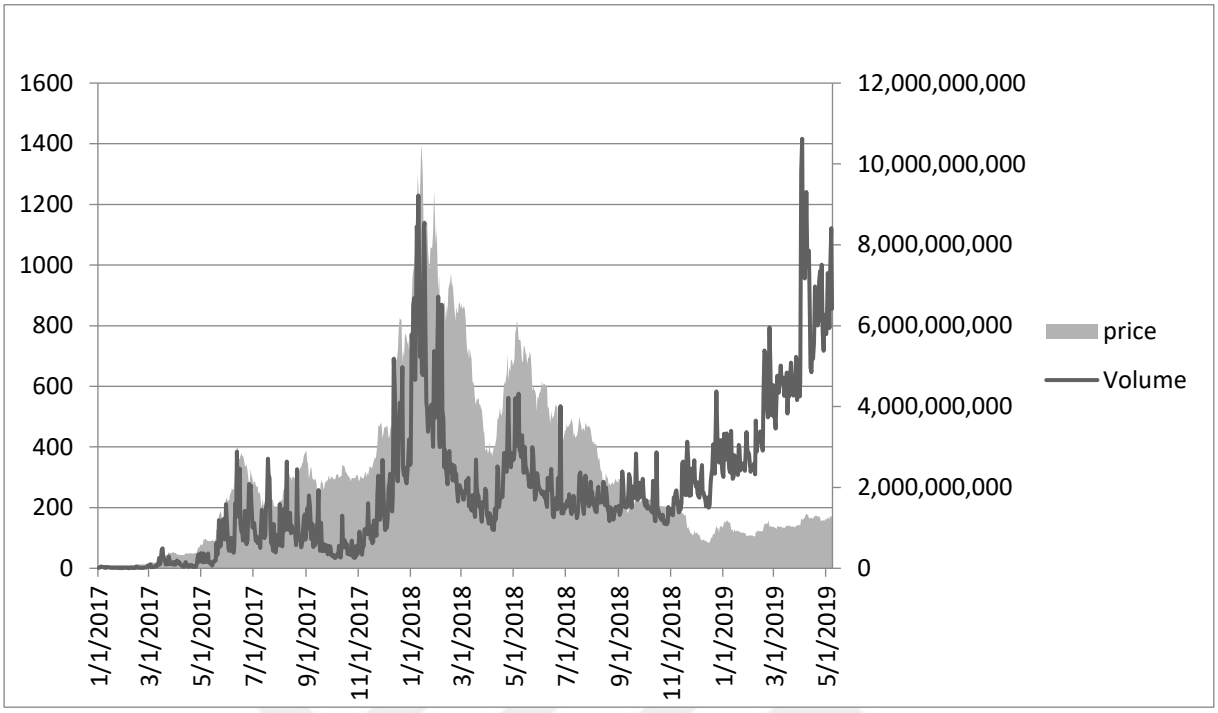


**Figure 2.** Ethereum Price (USD) & Trading Volume

**Source**: https://coinmarketcap.com/currencies/ Ethereum (05.04.2019)

### 2.2.3. Ripple

Ripple was launched in the year 2012, it serves as a global settlement network for other currencies like EUR, GBP. According to the claim of Ripple, it connects a number of banks (MUFG Bank, Santander etc.), payment providers (American Express, transferGo etc.) and digital asset exchanges (Bitstamp, Coincheck etc.) via RippleNet. Again respectively to ripple's assertion, Ripple Net offers one frictionless experience for sending money worldwide.

Ripple is considered to be the 2nd or 3rd largest cryptocurrency when taking into the account the market cap. Ripple is a privately produced by a company which bears a similar name to that of the currency and it is used to make payments in other currencies and other financial instruments over the network.[60] Ripple's transactions can take place in any fiat currency, digital currency or financial assets, but the transaction fee must be paid in ripple token (XRP). It differentiates from other cryptocurrencies by its circulating system. Whenever a

[60] Ammous, p, 16.

transaction occurs the XRP which was used in that transaction is destroyed forever and the supply is therefore reduced.[61]

When Ripple was created 100 billion XRPs were produced, out of the said amount, 20 billion XPRs were kept in the possession of the creator of the currency. The remaining 80 billion XRPs were handed over to the Ripple labs for the purposes of funding operations. 15 billion of those XRPs have been distributed among users, developers, merchants, gateways and market makers.[62] XRP Price (USD) and Trading Volume in dollars, displays that in 2017 price and trading volume of the XRP increased sharply.

In addition, the technology cause banks and non-bank financial service firms to comprise the Ripple protocol into their own systems so that their clients can use the service in this manner. Ripple depend on a regular shared ledger. This ledger has distributed database storing information about all Ripple accounts. The network is monitored by a network of independent validating servers. Moreover, Ripple Labs assisted banks in integrating with the Ripple network. Interestingly, new ledger is created every few seconds, and the last closed ledger is a ideal record of all Ripple accounts as acknowledged through server network. Figure 3 illustrated the XRP Price (USD) and Trading Volume in dollars in different years. It shows the changes of Price and also Trading Volume in detail.

[61] Ammous, p, 16.
[62] Ammous, p, 16.

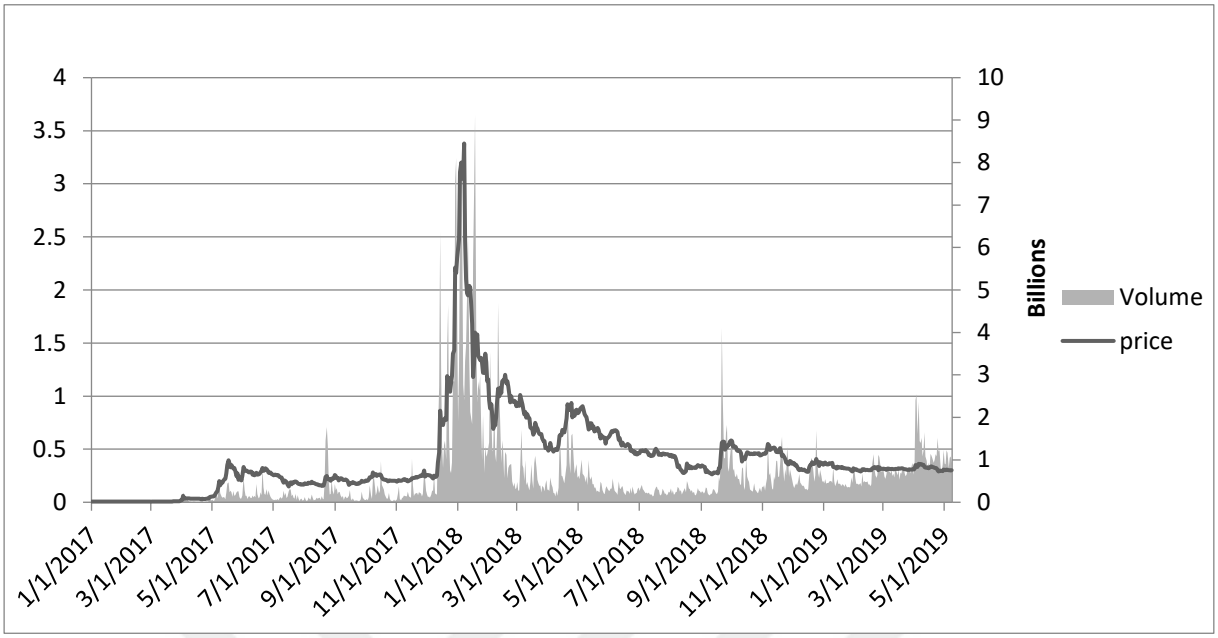


**Figure 3.** Ripple Price (USD) & Trading Volume

**Source**: https://coinmarketcap.com/currencies/ Ripple (05.04.2019)

### 2.3.4. Dash

Dash is a digital currency centered on privacy with immediate transactions which was used to be referred to as Darkcoin or Xcoin.[63] With the help of a secure open source platform, Dash is used to make fast, private payments online or in store.[64] The transactions are quicker and much more private than many of the other currencies. There are several prepaid debit cards that can be loaded with Dash and spent in local currencies.Dash is loosely based on Bitcoin's foundation and in such regards, it shares a lot of similarities in terms of properties. However, Dash has improved much of Bitcoin's single-tier network that it is the first cryptocurrency platform using the two-tiered network.[65]

[63] Stephen Chanet et. al , "A Statistical Analysis of Cryptocurrencies", *Journal of Risk and Financial Management*, 2017, Vol.10, No.2, https://econpapers.repec.org/article/gamjjrfmx/v_3a10_3ay_3a2017_3ai_3a2_3ap_3a12-_3ad_3a100126.htm (15 March 2019), p. 3.
[64] https://www.dash.org/ (10 March 2019).
[65] Stephen Chan, et el, p.3.

In a two-tier network, the first tier is responsible to operate the decentralized blockchain whereas the second tier (masterodes) makes away with the need for a third party and makes functions such as financial privacy and instant transactions possible.[66]

The dash coin system is relied on the fact that to approve a transaction at least 50%+1 of the community need to have the same copy of the ledger. Herein, manipulating the system becomes almost impossible which means that it is so hard to be hacked. For example, a hacker, must modify, with the acceptance of the owners, thousands copy of the ledger simultaneously. Dash support InstantX technology which have one of the most important aspects where allows DASH to stand on its own from a Point of Sale perspective. This technology makes users to have near-instant transaction confirmations without making any additional bloat in the block chain. Figure 4 shows Dash Price (USD) and Trading Volume in dollars in detail for different years. As it is seen from the figure, Dash experiences a sharp increment both in price and trading volume in 2018.

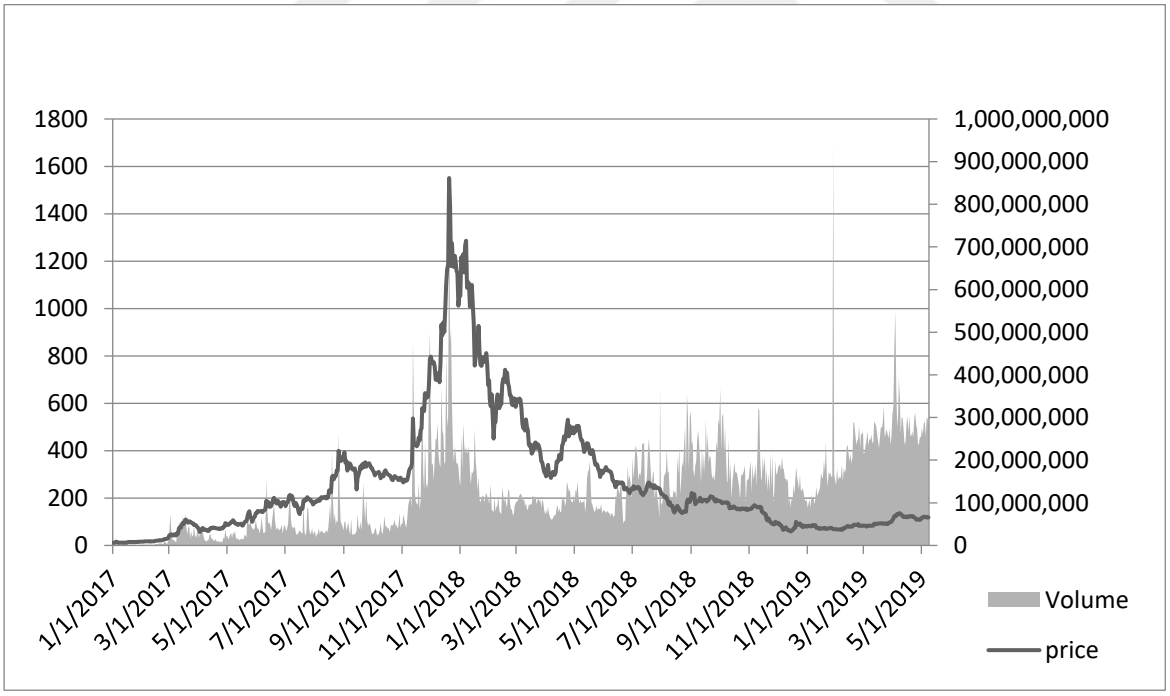


**Figure 4.** Dash Price (USD) & Trading Volume

**Source**: https://coinmarketcap.com/currencies/ Dash (05.04.2019)

[66] Stephen Chan, et el, p.3.

## III. BITCOIN AS A CURRENCY

### 3.1. Bitcoin; Its characteristics and features

The characteristics and features of Bitcoin should be discussed clearly before arguing that Bitcoin is a currency or not. To do so, the system of Bitcoin will be discussed in this section.

#### 3.1.1 Online Operations of Bitcoin

To start with, it should be mentioned that Bitcoin is a currency, which operates through online transactions, which are performed via an open source algorithm that has a user interface mobile applications or web interfaces in different online platforms. These user interfaces make the Bitcoin wallet accessible.[67] According to the pioneer, the Bitcoin systems were designed to be able to operate through an online peer-to-peer (P2P) network system.[68]

Since Satoshi Nakamoto intended that Bitcoin should permit internet payments to be performed directly between parties without a supervision of financial institutions. The online transactions would be possible by assigning a unique digital finger print to every user which would allow them to trade Bitcoin in exchange for goods and services.

As online transactions is a key feature of Bitcoins, those transactions are recorded on an online public ledger known as Blockchain and they are verified by network nodes.[69] Bitcoin has no physical form thus the only way to resolve double-spending problem is to record them on the public ledger.[70]

The online transactions of Bitcoin are complex based on their technical algorithms. This complexity limits the number of institutions which would be willing to accept the payment of Bitcoins which in turn limits the markets that Bitcoin can be used.

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[67] David Lee Kuo Chuen, Li Guo, and Yu Wang, "Cryptocurrency: A New Investment Opportunity?" *The Journal of Alternative Investments*, 2018, Vol.20, No.3, https://jai.iijournals.com/content/20/3/16 (22 March 2019), p. 6.

[68] Satoshi Nakamoto, "Bitcoin: A Peer-to- Peer Electronic Cash System", 2008, https://bitcoin.org/bitcoin.pdf (23 March 2019), p. 1.

[69] David Lee Kuo Chuen, Li Guo, and Yu Wang, p. 6.

[70] Jeanne L Schroeder, "Bitcoin and the Uniform Commercial Code**", Cardozo Legal Studies Research Paper No. 458**, 2015, https://ssrn.com/abstract=2649441 (23 March 2019), p 7.

### 3.1.2 Bitcoin is a Decentralized Currency

Bitcoin is not backed by any central authority such as government or a central bank of any particular place which discriminates it from all other "traditional" currencies.[71] This is why Bitcoin currency is called as decentralized currency.

Bitcoin is not under the regulation of any central authorities to control its production and distribution thus it is not subjected to the traditional monetary policies that are issued by central authorities such as central banks. How Bitcoin is generated is a matter of question since there is not a central bank to issue as traditional fiat currencies. Bitcoin is issued through a process called mining in which valid transactions are compiled together to form blocks and they are added to the ledger creating a link to the previously accepted blocks.[72] This process is done by people called miners who use CPU power of their processors to verify, record the transaction on the blockchain.

### 3.1.3. Account System of Bitcoin

The Bitcoin Core software runs Bitcoin network and it works as a digital wallet to perform transactions and it stores a copy of the blockchain. It is free to use and download but the user has to pay for the transaction fees. The algorithm secures a high level of privacy for the transactions and it enables the user to validate the transactions without a third-party. The unit of account for the Bitcoin currency is represented by the symbol BTC or XBT.[73]

## 3.2. Historical Development of Bitcoin and its Market Price

As it has been mentioned in the previous sections above, there were other attempts to establish cryptocurrencies like B-money and Bit Gold to compete on the market with the fiat currency. However, Bitcoin is the first cryptocurrency established and accepted as a medium of exchange. The efforts made by different individuals to establish a cryptocurrency before Bitcoin are contributed to the current status of Bitcoin. Due to the efforts of the previous

[71] Schroeder; p. 6.
[72] Karl J. O'Dwyer and David Malone, "Bitcoin Mining and its Energy Footprint", 25th IET Irish Signals & Systems Conference 2014 and 2014 China-Ireland International Conference on Information and Communications Technologies (ISSC 2014/CIICT 2014), Irland: 26-27 June 2014, p. 285.
[73]Adam Hayes, "Cryptocurrency Value Formation: An Empirical Analysis Leading to a Cost of Production Model for Valuing Bitcoin", 2016, Vol.34, No.7, https://ssrn.com/abstract=2648366 (30 March 2019), p.2.

endeavors, Bitcoin has been established as a force on the market and become an object of serious investments and academic research.

After many years of research, publications and attempts to establish a cryptocurrency, in 2008, Satoshi Nakamoto authored a paper *Bitcoin: A Peer-to- Peer Electronic Cash System* in the cryptography mailing list.[74]

In his paper, Nakamoto provided the definition of an electronic coin as a chain of digital signatures.[75] He continued on to provide the backbone of the peer to peer electronic cash system by saying that;

"*What is needed is an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party. Transactions that are computationally impractical to reverse would protect sellers from fraud, and routine escrow mechanisms could easily be implemented to protect buyers."*[76]

By stating the above, Nakamoto was conveying the idea that the electronic payment system that he established was to do away with elements that have been an intrinsic part of the commercial world, historically. These elements that were to be replaced by the electronic cash system were trust and accountability. The paper asserts that the new electronic cash system would operate without the requirement of the two transacting parties knowing each other.

After the publication of the paper in the year 2008, Nakamoto waited for one year before the commencement of the actual Bitcoin transactions. In January 2009 the first actual Bitcoin transaction took place through an open-source software. Hal Finney was the first to download the Bitcoin software and received the first 10 Bitcoins from Nakamoto, this marked the first transaction of Bitcoin.[77]

[74] Nakamoto, 2008.
[75] Nakamoto, p. 2.
[76] Nakamoto, p. 1.
[77] Usman Chohan, "A History of Bitcoin", 2017, UNSW Business School, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3047875 (30 March 2019), p.4.

From 2009 thereon Bitcoin became popular and people started investing, Bitcoin exchanges were established so that those individuals who need more Bitcoins can have them. To this effect, an exchange rate for Bitcoins was established, in October 2009 1USD was 1,309.03 Bitcoins.[78]

From 2009 up to the year 2011, the Bitcoin exchange rate did not experience any rise at all. The market price of Bitcoin in these two years remained at zero ($0.00). It was not until January the 30th that Bitcoin saw its first shift in the market price when the price of Bitcoin rose from zero to $1.00.[79] This was the beginning of a rise which would see unprecedented amounts.

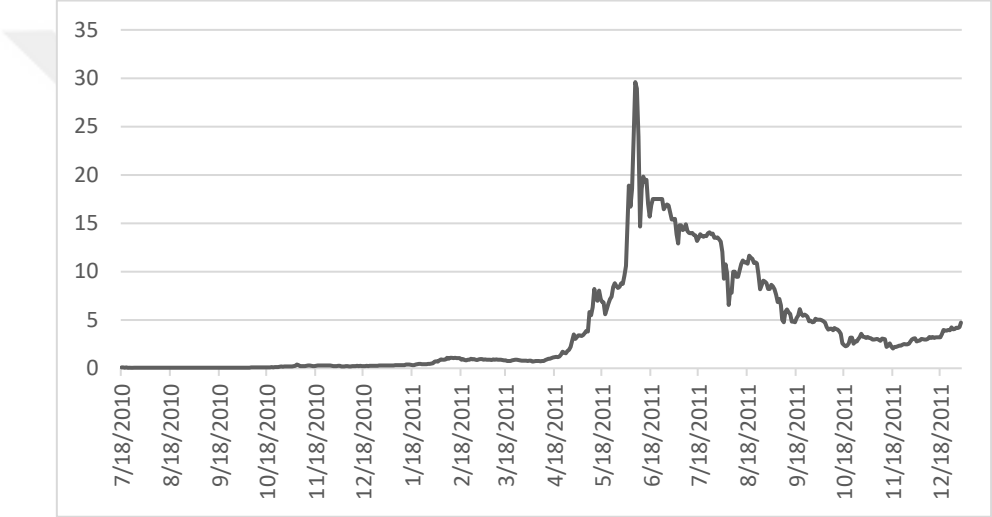


**Figure 5.** Bitcoin Market Price (USD) July 2010-Dec 2011

**Source:** https://www.buybitcoinworldwide.com/price/ (02.04.2019)

Figure 5 shows the market price of Bitcoin from its early days on the market in the year 2010 to the year 2012 when it moved from $0.00 to $30.00 in 90 days.[80]

From there on Bitcoin moved steadily on the market unit it experienced a rise in prices on 8th of June when the prices rose up to $29.60. However, it did not hold for long as the prices

[78] Kelvin FK Lowa and Ernie GS Teob, "Bitcoins and other cryptocurrencies as property", *Law, Innovation and Technology*, 2017, Vol. 9, No. 2, https://doi.org/10.1080/17579961.2017.1377915 (1 April 2019), p. 239.
[79] Oriana Ngo," Bitcoin Price History: An analysis on the events affecting bitcoin market ", University of Virginia, Department of Computer Science,http://bitcoin-class.org/projects/ngo.pdf (1 April 2019),p.2.
[80] *"Bitcoin Price History Chart",* https://www.buybitcoinworldwide.com/price/ (2 April 2019).

for Bitcoin started to decline again in the months that followed so much so that by the end of November the priced had reached $2.33.[81]

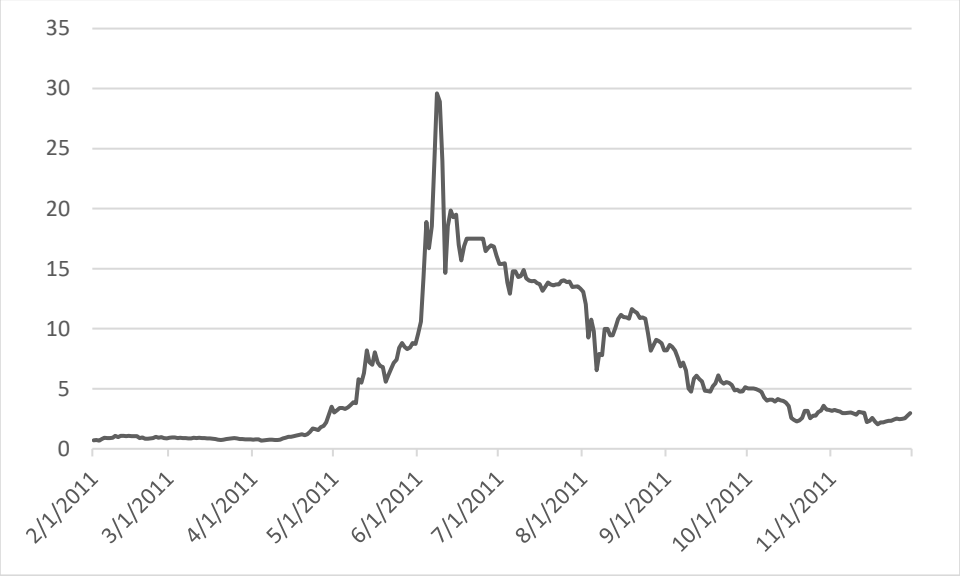


**Figure 6.** Bitcoin Market Price (USD) Jan 2011-Nov 2011

**Source:** https://www.buybitcoinworldwide.com/price/ (02.04.2019)

Figure 6 shows the market prices of Bitcoin starting from the first week of February 2011 up to the last week of November 2011. It was speculated that the decline in the price of Bitcoin in this period was liked caused by security concerns among the investors.[82]

During the period of starting from 30th November 2011 up to 1st December 2012, there was a significant rise in the market price of Bitcoin. The market price reached its peak on 15th August 2012 when it reached $13.50, however, from thereon it kept fluctuating that by the 1st December 2012 the market price for Bitcoin was $12.56.[83]

[81] *"Bitcoin Price History Chart*", https://www.buybitcoinworldwide.com/price/ (2 April 2019).
[82] Oriana Ngo, p. 2.
[83] *"Bitcoin Price History Chart",* https://www.buybitcoinworldwide.com/price/ (2 April 2019).

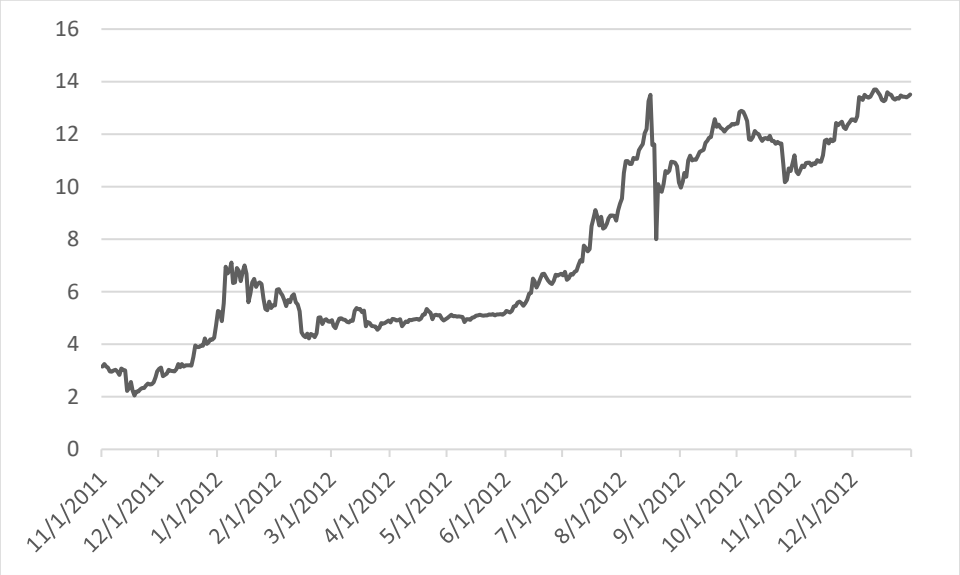


**Figure 7.** Bitcoin Market Price (USD) Nov 2011-Dec2012

**Source**: https://www.buybitcoinworldwide.com/price/ (02.04.2019)

Figure 7 demonstrates how the prices of Bitcoin faired on the market from November 2011 to December 2012.

From December going onto the New Year, Bitcoin prices were increased highly so that by 9th April 2013 Bitcoin market price peaked up to $230.[84] Without any warning, on the 10th of April Bitcoin crushed, declining from $230 to $165 within a short time, by 16th of April the prices had dropped to $68.36.[85] The investors were panicked because there is not a specific reason for the decline. Speculations and rumors filled the air but no concrete reason was provided for the decline. After the crush, the prices peaked but never reach to rates before the crush which in turn decreased the prices more to $101 at the end of June 2013.

[84] *"Bitcoin Price History Chart",* https://www.buybitcoinworldwide.com/price/ (2 April 2019).
[85] *"Bitcoin Price History Chart",* https://www.buybitcoinworldwide.com/price/ (2 April 2019).

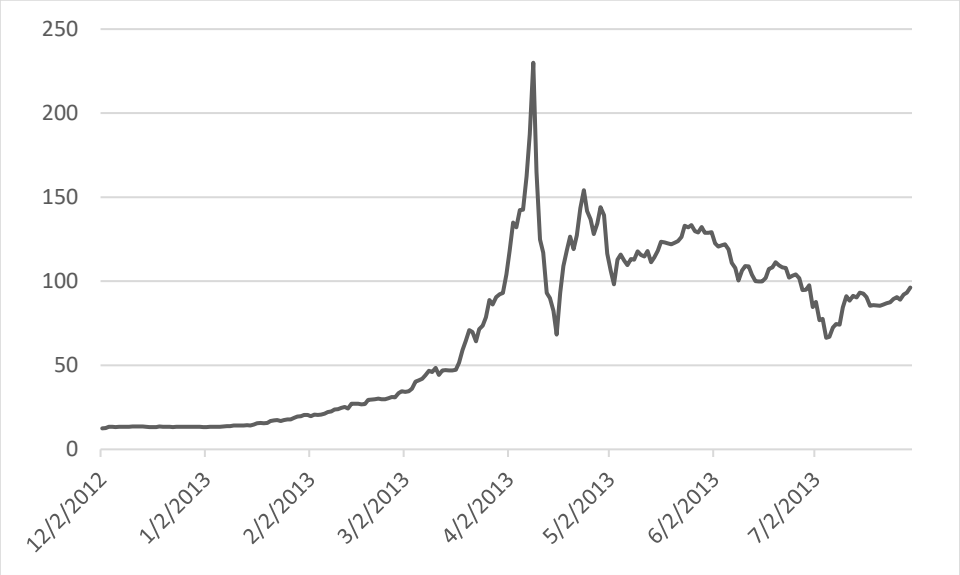


**Figure 8.** Bitcoin Market Price (USD) Dec 2012- June 2013

**Source:** https://www.buybitcoinworldwide.com/price/ (02.04.2019)

Figure 8 shows the market price of Bitcoin from December 2012 to June 2013. It projects the crush of bitcoin which occurred on 10th April 2013.

Following the crash that occurred in April 2013, the price of Bitcoin on the market remained relatively at a low level up to early November 2013. In November 2013 the prices peaked to an unbelievable level, $1,120, by the end of November and $1,147 during the first week of December. This rise in the market price was attributed to the interference of Chinese buying on the Bitcoin market with a sudden interest in Bitcoin.[86] But this was the highest price of Bitcoin during that period up to December 2014 because Bitcoin experienced a decline on the market such that by 30th December 2014 the price market of Bitcoin was decreased to $309. Once again the decline could not be explained with concrete reasons, however, according to some of the financial analysts the decline was due to the announcement of the Chinese government that financial banks in China should not accept Bitcoin as legal tender, on 5th December 2013. (Figure 9)[87]

[86] *"Bitcoin Price History Chart",* https://www.buybitcoinworldwide.com/price/ (2 April 2019).
[87] Oriana Ngo, p. 5.

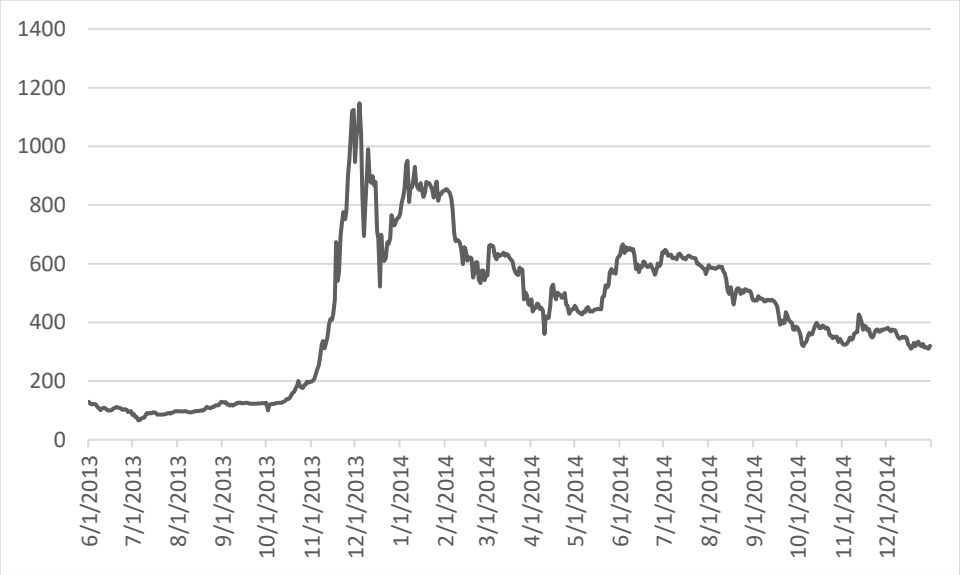


**Figure 9.** Bitcoin Market Price (USD) June 2013- Dec 2014

**Source:** https://www.buybitcoinworldwide.com/price/ (02.04.2019)

After the decline of the market price of Bitcoin, it did not increase dramatically for a couple of months, however, the volume of exchange had an impact on its recognition as a commodity. On 18th September 2015, the US regulator The Commodity Futures Trading Commission (CFTC) announced that they are classifying Bitcoin as a commodity in the USA covered by the Exchange Act along with such other commodities as oil and gold.[88] The implication of this announcement was that if the firms are planning to trade Bitcoin, they had to be registered with the commission otherwise they were forced to cease trading. Though, this announcement did not have much impact on the market price of Bitcoin.

The European Court of Justice, on 22nd October 2015, rules that Bitcoin transactions were not subject to Value Added Tax (VAT) in the European Union.[89] They clarify that Bitcoin transactions are exempted from VAT because they fall under the category of a transaction

[88] Matt Clinch, *"Bitcoin now classed as a commodity in the US"* ,2015, https://www.cnbc.com/2015/09/18/bitcoin-now-classed-as-a-commodity-in-the-us.html (3 April 2019).
[89] *"No VAT! Bitcoin Exchanges Exempted from Value Added Tax in EU".*2015. http://www.newsbtc.com/2015/10/25/no-vat-bitcoin-exchanges-exempted-from-value-added-tax-in-eu/ (3 April 2019).

involving currency, banknotes and coins as they are used as legal tender.[90] This ruling by the European Court of Justice also did not have much impact on the market price of Bitcoin.

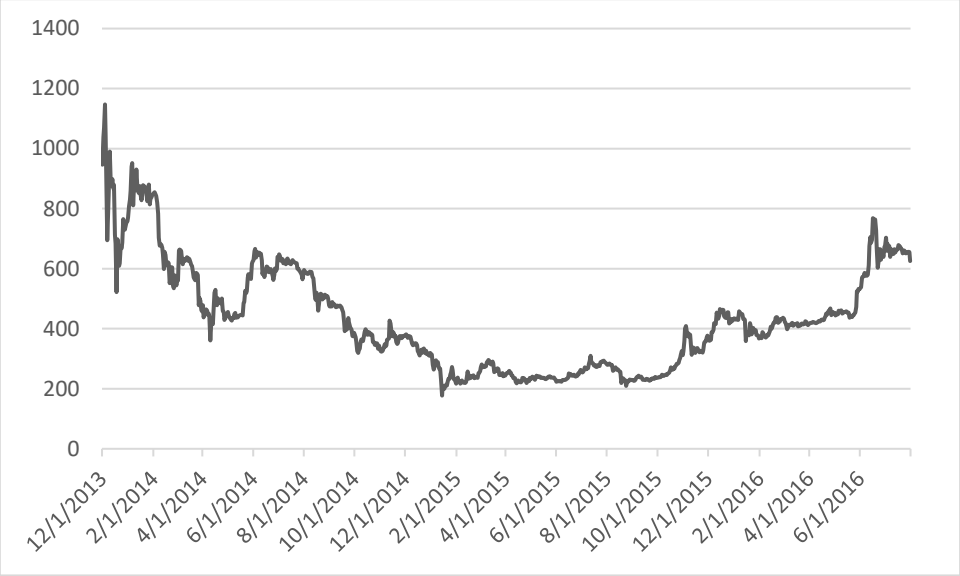


**Figure 10.** Bitcoin Market Price (USD) December 2013- July 2016

**Source:**https://www.coindesk.com/bitcoin-is-exempt-from-vat-says-european-court-of-justice/(02.04.2019)

Figure 10 shows the Bitcoin exchange price in USD. It shows the decreasing of the Bitcoin exchange price in 2014 and 2015 years which is then increased dramatically after 2016.

On the 3rd of December 2013, Bitcoin experienced a rise in its market price by passing the $1000 level, which was the first time in 3 years that the market price of the cryptocurrency experienced such a peak.[91] There are many factors that analysts claimed contributed to the boom in the price, among them were that the election of Donald Trump to the presidency of USA had caused the peak in the price while others claimed it was the devaluation of the Chinese Currency (Yuan) and the increase in the number of professional investors in Bitcoin with geopolitical uncertainty caused the dramatic increase.[92] Bitcoin fluctuated around a decent and stable market

[90] Yessi Bello Perez, *"Bitcoin is Exempt from VAT, Rules European Court of Justice*", 2017 https://www.coindesk.com/bitcoin-is-exempt-from-vat-says-european-court-of-justice/ (3 April 2019).
[91] Arjun Kharpal, *" Bitcoin breaks $1,000 level, highest in more than 3 years* ", 2017, https://www.cnbc.com/2017/01/02/bitcoin-breaks-1000-level-highest-in-more-than-3-years.html (2 April 2019).
[92] Arjun Kharpal, *" Bitcoin breaks $1,000 level, highest in more than 3 years* ", 2017, https://www.cnbc.com/2017/01/02/bitcoin-breaks-1000-level-highest-in-more-than-3-years.html (2 April 2019).

price during this period up to July 2017 and managed to remain between the levels of $200-1000.

Figure 11 illustrated the Bitcoin exchange price changes from 2016 up to 2017. It is clear that April 2017, price of Bitcoin exchange has improved.

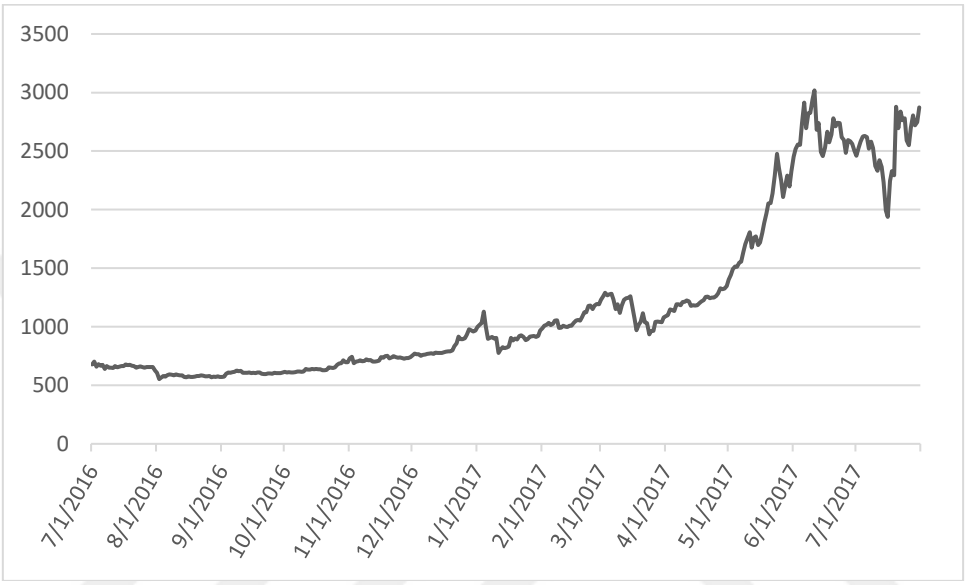


**Figure 11.** Bitcoin Market Price (USD) July 2016- July 2017

**Source:**https://www.cnbc.com/2017/01/02/bitcoin-breaks-1000-level-highest-in-more-than-3-years.html (02.04.2019)

It is clear from figure 12 that there has been a continuous rise in the market value of Bitcoin since July 2017. The rise has been so tremendous that it has broken records of market prices for Bitcoin. On 19th November 2017 Bitcoin prices peaked by breaking a new record of $8,000, this represented a more than 47 percent increase from the price of $5, 857 which Bitcoin had fallen to on 12th November 2017.[93] Bitcoin market price was peaked to $10,000 on the 29th of November for the first time in its history. This rise in the market price had taken the world by surprise as not many people expected to see such an increase in the market.[94] By the end of November the price was stabilized but in the second half of December 2017, the market price

[93] Arjun Kharpal,"Bitcoin hits new record high, breaking $8,000 for the first time" ,2017, https://www.cnbc.com/2017/11/20/bitcoin-hits-new-record-high-8000.html (2 April 2019).
[94] Lucinda Shen, *"Bitcoin Has Crossed the $10,000 Mark for the First Time"*,2017, http://fortune.com/2017/11/28/bitcoin-price-10000-buy-coinbase/ (5 April 2019).

of Bitcoin reached $17,585.[95]It was speculated that such a dramatic incline in the market price is was due to the recognition of Bitcoin as a legal tender in Japan by the Japanese Government on 1st April 2017 which made it possible to payment using Bitcoin as currency in Japan and other factors.[96]

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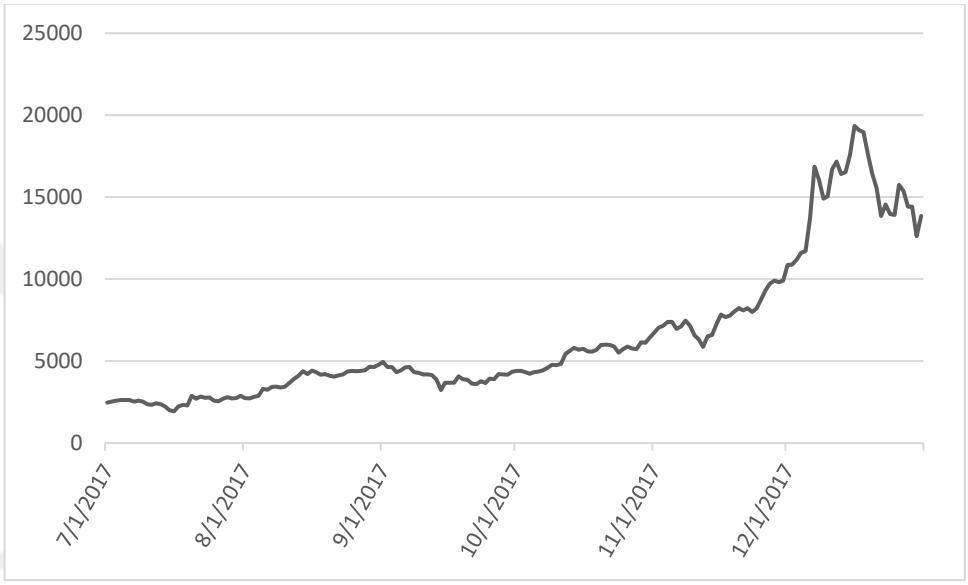


**Figure 12.** Bitcoin Market Price (USD) July 2017- Dec 2017

**Source:**http://fortune.com/2017/11/28/bitcoin-price-10000-buy-coinbase/ (02.04.2019)

### 3.3. Bitcoin vs Fiat Currency

Stating the differences between Fiat currencies and Bitcoin is fundamental to argue if Bitcoin could be accepted as a currency worldwide. From this point of view, the Bitcoin and fiat money will be compared in terms of source of supply, cost of transactions and anonymity.

#### 3.3.1 The Sources of Supply

The first fundamental difference between Bitcoin and the fiat currency is their supply sources. Fiat money is issued by authorities such as central banks and private or governmental

[95] *"Bitcoin Price (BTC)",* 2018, https://www.coindesk.com/price/bitcoin (2 April 2019).
[96] "*Why did Bitcoin rise in 2017?"* 2017, https://www.quora.com/Why-did-Bitcoin-rise-in-2017 (2 April 2019).

banks are responsible for the distribution of the money into the economy.[97] Following issuing the fiat currencies, the central banks make monetary policies to regulate the value, stability and amount of the currency to ensure supply-demand balance among other currencies and commodities.[98]

Contrary to the supply policy of the fiat currencies, the Bitcoin is supplied by a software which allows the miners to issue based on the CPU power of their computers and those miners perform the initial transactions, thus its supply is not regulated via any central authority.[99] At this point, it must be pointed out that Satoshi Nakamoto had created Bitcoin with a limited supply of 21 million Bitcoins which are expected to be mined up to 2140.[100] More than 80% of the total amount of Bitcoin is already in circulation thus unlike other fiat currencies it is expected that bitcoin supply will be exhausted in the near future.

In figure 13, Bitcoin Money Supply Over Time has been shown. 50 Bitcoin was received by miners from original payment.

Every 210.000 blocks this number is halved. Currently, miners receive 12.5 Bitcoin. This is done in order to limit the total supply of Bitcoin that will eventually be created. It is estimated that the final Bitcoin will be mined in the year 2140. By then there will be almost 21 million Bitcoin in existence.

[97] European Central Bank, Monthly Bulletin, 2012, https://www.ecb.europa.eu/pub/pdf/mobu/mb201210en.pdf (5 April 2019), p.65.
[98] European Central Bank, Monthly Bulletin, 2012, p. 67.
[99] Hayes, p, 2.
[100] Adam Barone, *"What Happens to Bitcoin After All 21 Million Are Mined?"* ,2019 https://www.investopedia.com/news/what-happens-bitcoin-after-all-21-million-are-mined/ (5 April 2019).

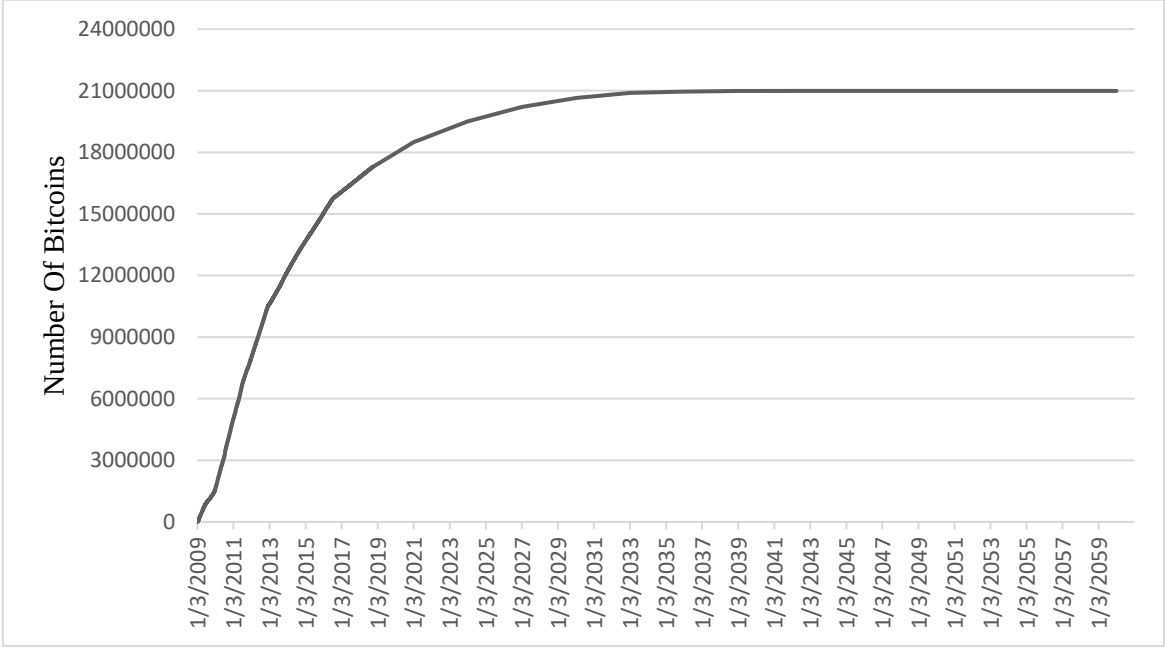


**Figure 13.** Bitcoin Money Supply Over Time

**Source:**https://coinivore.com/2017/08/10/andreas-antonopoulos-explains-bitcoins-21-million-supply-cap/ (02.04.2019)

### 3.3.2 Transaction Costs

The other fundamental difference that exists between Bitcoin and the fiat currency is the transaction costs. The fiat money can be transacted without any costs, especially for the daily transactions, in the physical form however if one desires to transact through the internet there is a need for a third party to regulate the transaction and this results in additional costs. These costs may vary according to the sum of money which is being transacted as well as the distance between the two transacting parties.

However relatively speaking, the cost of Bitcoin transactions is less than those of fiat currency transactions. While it is true that the price of Bitcoin transactions has risen recently compared to the past, it still remains less expensive in comparison to the cost of fiat money transactions.

In figure 14 average Bitcoin transaction cost in USD is illustrated between 2010 and 2018. The division of miner revenue that consists of both transaction fees and block rewards, by the number of transactions reveals the average transaction cost. While the term transaction fee is

self-explanatory, the term block reward is used to define bonuses given by the blockchain network to the miners every time they complete the mining process of a block. While the value of Bitcoin increased to $1,000 approximately in 2013; transaction cost also increased up to $80.[101]

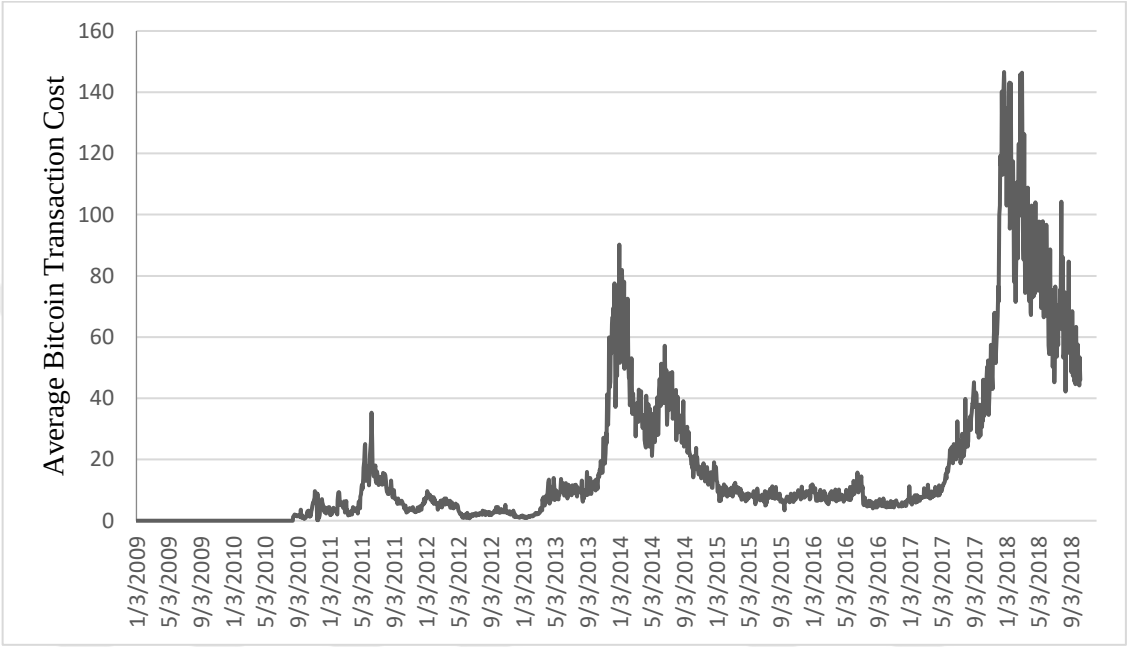


**Figure 14.** Average Bitcoin Transaction Cost Jan 2009- October 2018

**Source**: https://www.blockchain.com/charts/cost-per-transaction?timespan=all (05.04.2019)

### 3.3.3 Anonymity of Transaction

The anonymity of transactions another important difference between Bitcoin and fiat currency. Whereas with transactions involving credit cards and debit cards, the identity of the parties and the details of the transaction are known, with Bitcoin the online transactions are anonymous so that the parties do not need to know each other. The Bitcoin transactions are made in such a way that the public can see that a transaction is being conducted by two individual but the information is limited in such a way that it cannot be linked to anyone.[102]

[101] *"Rising Transaction Costs Could Trigger a Bitcoin Price Crash: CME Economist"*, 2017,http://dailybitcoinnews.com/rising-transaction-costs-could-trigger-a-bitcoin-price-crash-cme-economist/ (5 April 2019).
[102] Nakamoto, p. 6.

### 3.4. Bitcoin Transactions

To understand how Bitcoin operates as a currency, Bitcoin transactions should also be investigated. With that point of view, Bitcoin transactions and the important elements of Bitcoin will be discussed.

In the previous sections, it was discussed that Bitcoin is a decentralized currency and it operates without the need or intervention of a third party in the form of a government or central banks. It has also been mentioned that Bitcoin uses a peer-to-peer network system which enables two individual to make transfers between themselves directly.

The transactions of Bitcoin have been designed, first hand, by the rules provided by Satoshi Nakamoto in his paper in 2008, wherein he presented the idea of Bitcoin. However, it is possible, by common agreement, for the team on duty to supervise the software, as well as minors to revise those rules whenever necessity demands so.[103]

#### 3.4.1. The Use of Cryptographic Algorithms

Bitcoin uses cryptographic algorithms in their transactions, this helps the system for maintaining security and protect against fraud and counterfeit.[104] For the transactions to be possible, the users of Bitcoin must download and use the required software. The Bitcoin cryptographic process uses digital signatures as well as cryptographic hash functions.[105]

##### 3.4.1.1. Digital Signatures.

In transactions, digital signatures are generally used by two parties in order to make the payment or transfer possible by issuing such instructions.[106] Digital signatures are very popular on the internet and electronic transactions because they assist in the authentications of transactions. Generally speaking, digital signatures have three very specific attributes. First of all, it enables the authentication of transactions or exchange by the receiver with a

[103] Gerald P Dwyer, "Blockchain: A Primer",2016,
Clemson University Australian National University (ANU) - Centre for Applied Macroeconomic Analysis (CAMA), https://ssrn.com/abstract=2900450 (5 April 2019), p.4.
[104] Lawrence J. Trautman & Alvin C. Harrell, "Bitcoin Versus Regulated Payment Systems: What Gives." Cardozo L. Rev. 38.1041,2016, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2730983 (5 April 2019), p. 1060.
[105] Anton Badev and Matthew Chen, "Bitcoin: Technical Background and Data Analysis", FEDS Working Paper No. 2014-104, 2014, https://ssrn.com/abstract=2544331 (6 April 2019), p. 7.
[106] Badev and Chen, p. 7.

communication from the sender.[107] The second attribute of digital signatures is that when the transaction has been completed, it cannot be repudiated or denied by the parties, specifically by the sender.[108] The third attribute of digital signatures is that the transactions conducted cannot be modified by any party seeking to dishonor the transaction hence this maintains the integrity of the transaction.[109]

Digital signatures are used by Bitcoin protocol to sign transaction messages.[110] This involves the use of public key encryption which produces two keys; one public key and another private key for the purposes of the transaction.[111] It must be stated that the use of digital signatures is not only peculiar to Bitcoin transactions. They have been used in many other electronic transactions as well other commercial transactions and communications involving the government.

#### 3.4.1.2. Hash Functions

The cryptographic hash functions are used to enforce discipline in writing transactions records in the public ledger.[112] The Bitcoin protocol uses a hash function known as a SHA-1 cryptographic hash function which is responsible for converting strings of arbitrary length into shorter ones which have length.[113]

### 3.4.2. Transaction Process

The Bitcoin transaction process involves several steps which are carried out between the individuals concerned. First of all the Bitcoins are stored in what is "Bitcoin addresses".[114] The address is a name for a public key in the Bitcoin transactions. The users of Bitcoin have wallets which allow them to trace their balances and to send and receive Bitcoins.[115] The wallets

[107] Starry Peng. " Bitcoin: Cryptography, Economics, and the Future ",2013,
University of Pennsylvania, School of Engineering and Applied Science, https://www.cis.upenn.edu/current-students/undergraduate/courses/documents/EAS499BitcoinThesis-StarryPeng.pdf (7 April 2019).
[108] Peng, p. 3.
[109] Peng, p. 3.
[110] Badev and Chen, p. 8.
[111] Badev and Chen, p. 8.
[112] Badev and Chen, p. 7.
[113] Peng, p. 4.
[114] Bollen, 2016, p. 1
[115] Dwyer, p, 6.

are in the form of a spreadsheet which keeps the balance. The Bitcoins are not physical coins instead they are a chain of digital signatures.[116]

#### 3.4.2.1. Blockchain transactions

At this point, it has been mentioned that Bitcoin uses cryptographic algorithms, and the Bitcoin users have an electronic wallet where all they have a follow up of their balances, send and receive Bitcoins. The Bitcoin transactions are performed from one to another address and all those transactions are recorded in a database called the blockchain.[117] The blockchain is an integral part of the Bitcoin currency because Bitcoins cannot be transferred without the use of the blockchain. The blockchain is a public decentralized ledger for all transactions to be followed.[118]

The blockchain, although a public ledger, does not show the identity of the individuals performing the transactions. When the transaction is commenced each individual has a public and a private key which prevents the identity of the individuals being known to the public.

#### 3.4.2.2. Verification of Transaction

To perform a Bitcoin transaction, an individual with a Bitcoin address needs to issue or sign a transaction message by using the private key which will be public afterward for all to see it on the Bitcoin network.

The Bitcoin protocol works to verify the transaction message within the Bitcoin network which should be verifiable as the owner of the message.[119] This is easily achieved because of the private keys for the particular Bitcoin are only in possession of the sender when the message is sent. The second issue is that it needs a second verification step via the Bitcoin network to be sure if there are enough funds at the sending address for the completion of the transaction.[120]

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[116] Peng, p. 5.
[117] Trautman and Harrell, p. 1061.
[118] Sinclair Davidson, Primavera De Filippi and Jason Potts, "Economics of Blockchain", Public Choice Conference, New York: May 2016, p.2.
[119]Badev and Chen, p. 13.
[120] Badev and Chen, p. 13.

#### 3.4.2.3 Bitcoin Mining

The participants of the Bitcoin network gather the intended transactions every 10 minutes into the "block".[121] These participants are referred to as miners. They spent the effort to verify the Bitcoin transactions by adding new transactions which have been gathered into a block in the blockchain.

The miner verifies the Bitcoin transactions by solving a mathematical problem which is not easy to calculate without a knowledge of the Bitcoin algorithm. The miners are engaged in a competition to find the solution to the mathematical problem. When the solution is found, it is sent to the Bitcoin network. If these solutions are accepted by the network then the intended transactions are added to the blockchain and the miners get a reward, in Bitcoin, for their effort which is called mining[122]. New Bitcoins are issued via the repetition of this process over and over depending on the CPU power of the miner's computers.

In figure 15, the process of the transaction has been shown. It is an electronic coin as a chain of digital signatures. As it is clear from the figure, the coin is transfered by each owner to the next owner through digitally signing a hash of the previous transaction. Then, next owner's public key is added to the end of the coin. A payee can confirm the signatures to verify the chain of ownership.[123]

[121] Björn Segendorf, "What is Bitcoin?" Sveriges Riksbank Economic Review, 2014
[122] http://archive.riksbank.se/Documents/Rapporter/POV/2014/2014_2/rap_pov_artikel_4_1400918_eng.pdf (7 April 2019),p.74.
[123] Nakamoto, p.2.

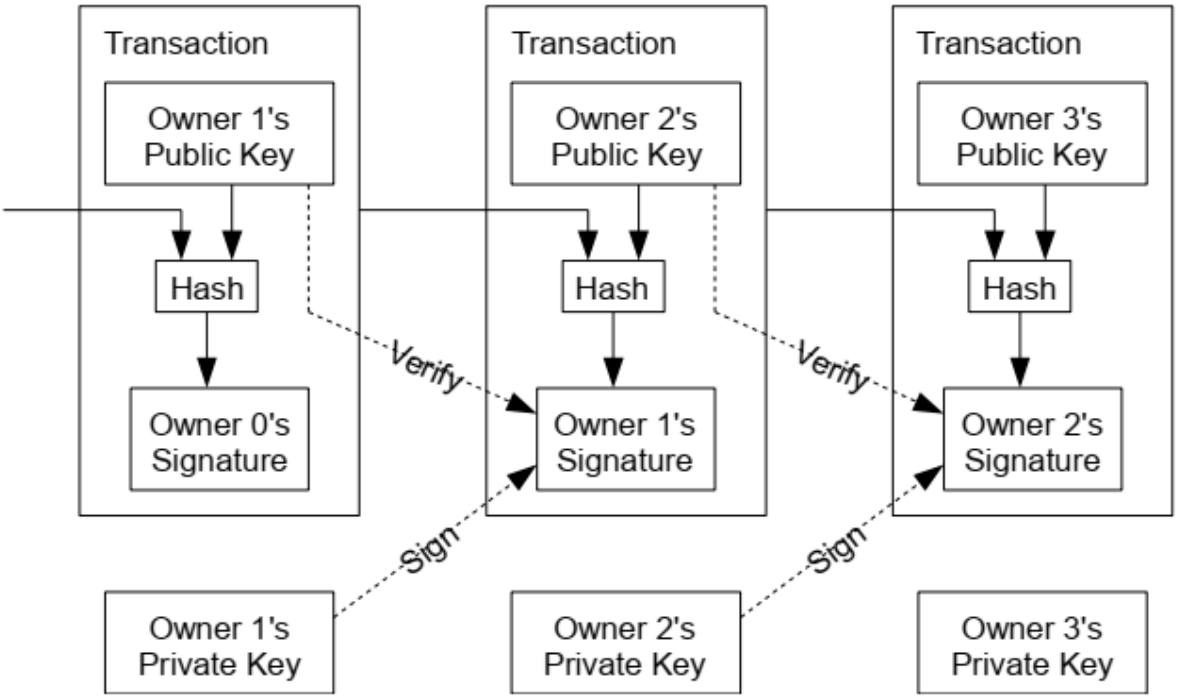


**Figure 15.** The Process of Bitcoin Transactions

**Source**: Satoshi (2008),"Bitcoin: A Peer-to-Peer Electronic Cash System", p.2.

### 3.5. The Functionality of Bitcoin as a Currency

Traditionally, a currency should possess three features which distinguish it from all other commodities. The physical form of the currency does not matter as long as it performs the required functions it is considered to be money.[124]

The first feature of a currency is that it should be capable of being used as a medium of exchange.[125] This is to say money should be accepted as a tool of payment for goods and services in a society. Currency simplifies and makes it possible the daily transactions of buying and selling. The second characteristic of money is be a unit of account[126] which meant that it can measure value of items as a standard. The third characteristic of money is that it functions

[124] Gregory Mankiw, Macroeconomics, 4th ed , New York: Worth Publishers, 1999, p 155-156.
[125] Susanne König, "The Evolution of Money", 2001, UNICERT IV Program, http://www.ww.uni-magdeburg.de/fwwdeka/student/arbeiten/009.pdf (9 April 2019), p, 4-5.
[126] König, p, 5.

as a store of value[127] meaning that it can keep the purchasing power of a commodity to spend it in future. For example, if a person has earned money today he can decide to keep it in order to purchase some goods after a period, the money should still valuable to purchase those items.

### 3.5.1. Bitcoin as a Medium of exchange

To be accepted as a currency, Bitcoin is expected to be used as a medium of exchange in the market at first. It must be stated that it is difficult to acquire accurate market data regarding the use of Bitcoin in the daily exchange of goods.[128] However some information can be obtained through the Blockchain which operates as a ledger for the Bitcoin via sophisticated software or through media and websites which readily provide information related to Bitcoin.[129]

When Bitcoin was launched, it was mainly used as a medium of exchange for online e-commerce sites.[130] Although limited, it can still be accepted as it fulfilled the purpose of being used as a medium of exchange. Bitcoin had expanded in its scope and became an acceptable medium of payment even for many traditional merchants within time[131] which is an indicator for the acceptability of Bitcoin as a medium of exchange. Following that, a lot of vendors and companies started accepting Bitcoin payments.[132] At present, there are over 100 multinational companies accepting Bitcoin as a medium of payment. These included IT companies such as Microsoft and Apple's Apple store, airline companies such as LOT Polish Airlines, as well as dress, real estate and electronic stores. Another example is that Bitcoin is accepted for micropayments, which are online transactions for small payments, in Germany.[133] Bitcoin is also started to be used to make a settlement in personal contracts between the involved parties.[134] In this circumstance, the receiving party may receive a currency of legal tender, a service, commercial or ordinary goods.[135] Although it can be clearly be seen that Bitcoin is

[127] König, p, 6.
[128] Gerald P. Dwyer,"The Economics of Bitcoin and Similar Private Digital Currencies", Clemson University, Australian National University (ANU) - Centre for Applied Macroeconomic Analysis (CAMA), 2014, https://ssrn.com/abstract=2434628 (9 April 2019) ,p.11.
[129] Gerald P. Dwyer,"The Economics of Bitcoin and Similar Private Digital Currencies, p. 12.
[130] Lo and Wang, p. 4.
[131] Lo and Wang, p. 4.
[132] Jonas Chokun, *"Who Accepts Bitcoins As Payment? List of Companies, Stores, Shops "* ,2018, https://99bitcoins.com/who-accepts-bitcoins-payment-companies-stores-take-bitcoins/ (9 April 2019).
[133] Aleksandar Arsov, "Bitcoin as an Innovative Payment Currency in Germany: Development of the e-Gold Standard", *Journal of International Business Research and Marketing* ,2017, Vol.2, No. 2, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2777205 (10 April 2019), p.33.
[134] Arsov, p, 36.
[135] Arsov, p, 36.

accepted as a medium of exchange in Germany, there is still not a clear legal stand on whether it is a currency because the government in Germany treats Bitcoin as a private currency.[136]

In the USA the status of Bitcoin is not well defined, for some it ought to be treated like a capital asset in some states.[137] However, one aspect is clear, Bitcoin is an acceptable medium of exchange in the USA for the purchase of goods and services. Although the regulations of such payments of goods and services may differ from state to state, there is overall acceptability of Bitcoin as a medium of exchange.

Generally speaking, the European Union has not taken a stance to Bitcoin issue, which makes it possible for EU countries to come up with their own regulations for Bitcoin. Switzerland has declared Bitcoin to be a foreign currency, while the UK allows the use of bitcoin as a medium of exchange and made policies to create a Bitcoin friendly environment in the UK.[138] Other EU countries have also accepted the use of Bitcoin as a medium of exchange although perhaps it appears that they still did not declare it as a formal currency, yet.[139]

Recently, the Australian government has started to make policies to regulate Bitcoin in the country.[140]

From the above, it can be said that Bitcoin has become an accepted medium of exchange for goods and services in these countries; although, it must be said that some countries have not started to accept Bitcoin as a legal currency, yet. Although indications are there that Bitcoin acceptability seems to penetrate throughout the world.

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[136] Arsov, p, 36.
[137] Mitchell Franklin, "A Profile of Bitcoin Currency: An Exploratory Study", *International Journal of Business & Economics Perspectives*, 2016, Vol. 11, No. 1, http://www.iabpad.com/a-profile-of-bitcoin-currency-an-exploratory-study/ (12 April 2019), p, 86.
[138] Kristina Frunze, *"Top countries where Bitcoin is legal",* 2017, https://atozforex.com/news/top-countries-where-bitcoin-is-legal/ (12 April 2019).
[139] Bajpai Prableen , *"Countries Where Bitcoin Is Legal & Illegal (DISH, OTSK)"*,2018, https://www.investopedia.com/articles/forex/041515/countries-where-bitcoin-legal-illegal.asp (13 April 2019)
[140] *"Australia follows Japan in move to regulate bitcoin"*, 2018,https://www.ft.com/content/4cd5cc3c-8309-11e7-a4ce-15b2513cb3ff (13 April 2019).

### 3.5.2. Bitcoin as a Unit of Account

To be regarded as a currency it must be possible to use it to measure the value of goods and services. For any currency to be regarded as a unit of account, it must be divisible, verifiable and fungible. Bitcoin serves as a unit of account which is derived from Bitcoin's functionality as a medium of exchange[141] such as vendors and companies that accept Bitcoin as a medium of payment for their goods and services find it more convenient to display and advertise such goods and services in the standard fiat currencies while allowing the same to be paid with Bitcoin currency. When a payment is done in Bitcoins, the merchants convert the Bitcoins received as payments into standard currencies. The main reason that merchants follow this particular method is that using the Bitcoin currency prices as this requires the usage of four or more decimals thus the prices can be perceived quicker by the buyers in standard currencies.[142] For example, the price of a phone may be quoted as $800 instead of 0.000456 BTC. This is done to convenience and it does not dispel its functionality as a unit of account.

Furthermore, Bitcoin is divisible so that it can fulfill the requirement of being a unit of account. A Bitcoin can be divided into 100 million as the smallest fraction, in other words, it is a hundredth of a millionth BTC[143] which proves that Bitcoin can be represented as ten to the power of 8 hence it fulfills the meaning of a unit of account as being a divisible entity.

A unit of account must be capable of being verified. Although Bitcoin is not backed by any government agencies or central authority, this does not prevent it from being verified with respects to its transactions. Bitcoin uses a peer-to-peer network system which has online public ledger called blockchain where all Bitcoin transactions are registered to blockchain for verification and to avoid double spending.[144] This shows that Bitcoin as a unit of account and capable of being verified.

Last but not least, Bitcoin is considered to be fungible as a unit of account which means it is possible to interchange one bitcoin for another. All Bitcoins are considered to be similar

[141] Lo and Wang, p. 10.
[142] Yermack, p. 12.

[143] Giulio Orsenigo and Alexander J. Tammuni, "The Rise Of A Digital Currency Era: Bitcoin Theory & Applications", 2016, Bocconi University, https://bocconiesa.files.wordpress.com/2016/04/bitcoins.pdf (15 April 2019), p.6-7.
[144] Trautman and Harrell, p. 1061.

therefore holders have the same Bitcoins. This feature further supports Bitcoin to be a unit of account.

It is also speculated that Bitcoin is not a unit of account due to its highly volatile value which can be considered as a negative factor. But it should be mentioned that it does not prevent Bitcoin from functioning as a unit of account. This is because legal tender of many countries which are backed by the central authorities may also experience volatility on the market. Even though the volatility rate of those currency may not experience such a high volatility it can still face those countries with catastrophic economic crises so that they can be devaluated a couple of times within a very short period. Thus the volatility rate of Bitcoin is still acceptable as it is a relatively new form of money and the volatility rate can be expected to be normalized within time.

### 3.5.3. Bitcoin as Store of Value

For an entity to be considered as a currency, it must be capable of being a reasonable value container, meaning that is must have the capability of maintaining its value for a certain amount of time. Traditionally, this means that the owners of the currency should be able to exchange it for goods and services at a future date when necessary.

Historically, maintaining the stored value of a currency also meant that it is protected against theft and physical damage. The latter can be done by depositing it in a bank with a physical form of currency such as a precious metal or a legal tender in the form of a paper or coin.[145]

The traditional currencies value is backed by various central banks for the areas in which they are operational or issued. The banks control and regulate the distribution of the currency in the economy as well as the inflation by their monetary policies. In this way, the central bank may lower the inflation by lowering the money supply and vice versa.

On the other hand, Bitcoin is not backed by any central authority to regulate the money supply. Hence its value is not subject to the control of central banks as the fiat currencies. This shows that the store value of Bitcoin cannot be the same as the central bank backing.

[145] Yermack, p. 14.

Furthermore, unlike fiat currency, Bitcoin has a stable and limited supply with the total number of 21 million Bitcoins which supports that Bitcoin will store its value in the market in future.[146] Thus people buy Bitcoins for the purpose of keeping them as a store of value as an investment rather than spending them.[147] Its being used as an investment currency is in agreement with Gresham-Copernicus' law which states that if there are two currencies are in operation, one that is trusted as a better value store will be saved and the inferior money will be used for transactions.[148]

Moreover, the fiat currencies are subjected to inflation within time, therefore their value reduces and their ability to function as a store of value will diminish as well. This gives an advantage to due to the fact that it is free from the interference of governments and central authorities and its total supply is limited to 21 million.[149]

As a virtual currency, Bitcoin is stored on computer reserves or accounts which are referred to as digital wallets. This protects the currency from theft, therefore, this preserves its functionality as a store of value.

### 3.6. Advantages of Bitcoin as a Currency

The popularity of Bitcoin as a currency in the market is rising and every day more people and companies are introduced with Bitcoin because they are realizing its benefits as a currency and a commodity to invest. This is, in turn, influencing many others and causes an increase in the transaction volume and market price. Here some of the advantages of Bitcoin will be discussed.

#### 3.6.1. Non-interference from Third Party

One of the factors which made Bitcoin popular is that it does not allow the interference of third parties in the transaction. Bitcoin transactions are performed without the

[146] Michal Polasik et. al., "Price Fluctuations and the Use of Bitcoin: An Empirical Inquiry", *International Journal of Electronic Commerce,* 2015, Vol.20, No.1, https://ssrn.com/abstract=2516754 (18 April 2019), p.16.
[147] Accoriding to Michal Polasik et al, research conducted since 2012 shows that 73% of addresses only receive Bitcoins and do not send them and that around 11% of Bitcoin have been held unused at addresses for more than 4 years, and 39% for more than a year.
[148] Polasik et al, p.16.
[149] D'Artis Kancs, Pavel Ciaian and Miroslava Rajcaniova, "The Digital Agenda of Virtual Currencies: Can Bitcoin Become a Global Currency?" European Commission Joint Research Centre Technical Report, the European Union, 2015, p. 13.

requirement of a third party as Central Banks or governments.[150] This serves to remove the various huddles that are faced by people when a third party is part of the transaction. Instead of the involvement of third parties, the Bitcoin transactions rely on a peer-to-peer network which makes it possible for one individual to transfer or make payment directly to another without going through financial institutions.[151] In addition to that any government or central bank do not have the authority to mandate, confiscate or seize the Bitcoins of an individual[152] because they are not issuing the Bitcoin currency thus has no power to control it.

### 3.6.2. Low Cost of Transactions

One of the other benefits of using Bitcoin is that the transaction costs are very low compared to those of the other currencies.[153] In addition to this, there are no charges such as bank account fees.[154] Furthermore, Bitcoin transactions are not subject to tax, generally speaking.[155] Owing to the fact that Bitcoin is decentralized and are not subject to interference from central banks, Bitcoin has been free from tax as there is no available way to implement taxation systems, yet.[156]

However, it must be stated that there are some countries working on policies to implement a tax system for Bitcoin like the USA where accountants are struggling with how they could tax Bitcoin currency transactions.[157] The UK, which treats Bitcoin as a private currency, is also planning to introduce value-added tax to Bitcoin under the British Tax Rules.[158]

### 3.6.3. Privacy

On top of other features, what makes Bitcoin different from fiat money and thereby giving it an advantage is the fact that its transactions are private. The Bitcoin transactions are designed to be performed without the need to reveal the identity of the parties involved in the

[150] Nakamoto, p. 1.
[151] Nakamoto, p. 1.
[152] Mauro Conti,et el, " A Survey on Security and Privacy Issues of Bitcoin", 2017, Cornell University, Cardiff Law School , https://ieeexplore.ieee.org/document/8369416 (20 April 2019), p.8.
[153] Ajibola Ogunbadewa,,"The Virtues and Risks Inherent in the 'Bitcoin' Virtual Currency", 2014, https://ssrn.com/abstract=2425114 (20 April 2019), p.2.
[154] European Central Bank Virtual Currency Schemes, October 2012, p. 21.
[155] Mauro Conti, et al, p. 8.
[156] Mauro Conti, et al, p. 8.
[157] Franklin, p. 85.
[158] Franklin, p. 87.

transaction.[159] This is quite different when compared other forms of payments and currencies like Pay Pal, credit cards and cheques.

The level of privacy that is involved in the Bitcoin transaction is such that unless users make their wallet address public, it is very difficult for the Bitcoin transactions to be traced back to the user.[160] Even if the user of Bitcoin chooses to make his wallet address public, this does not affect the privacy of Bitcoin much because a new wallet address can be easily generated within 10 minutes.[161] This, therefore, serves to make Bitcoin more private and secure to use.

In figure 16 and 17, the traditional and new privacy models have been illustrated. In traditional banking via limiting accessing of information to the parties, it is achieved to the level of privacy. Herein, privacy can still be kept via breaking the flow of information in another place through the keeping of the public keys anonymous which is so similar to the level of information released by stock exchanges. There is one risk that linking might display other transactions that belonged to the same owner if the owner of a key is exposed. In the new privacy model, as it shown in figure two steps have been limited.




**Figure 16.** Traditional Privacy Model

**Source**: Nakomato (2008),"Bitcoin: A Peer-to-Peer Electronic Cash System", p.6.

[159] Archana M. Naware, "Bitcoins,Its Advantages and Security Threats", *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)*, 2016,Vol. 5, No. 6, http://ijarcet.org/wp-content/uploads/IJARCET-VOL-5-ISSUE-6-1732-1735.pdf (21 April 2019), p. 1733.
[160] Conti, et al, p. 8.
[161] Conti, et al, p. 8.




**Figure 17.** New Privacy Model

**Source**: Nakomato (2008),"Bitcoin: A Peer-to-Peer Electronic Cash System", p.6.

### 3.6.4. Security of Bitcoins

The Bitcoins are stored in wallets as fiat currencies stored in bank accounts, these wallets are stored digitally and contain private keys which makes it hard to be accessed by another individual.[162] These private keys are used to authorize the Bitcoin transaction by the parties of the transaction. The algorithm of the wallets is designed to withstand harmful cyber-attacks. It is clearly seen that it is almost impossible to steal Bitcoins unless the potential thief has obtained possession of the Bitcoin wallet's private key with which they can be able to access the wallet of a user.

The other point is that fiat currency could be subjected to fraud and counterfeit, however, Bitcoins are designed and operate in such a way that it is not possible to forge them or double spend[163] because of the cryptographic algorithms which protect the currency from counterfeit and serves to protect the communication between parties thereby ensuring privacy.[164]

### 3.6.5. Transparency

Bitcoin is a decentralized currency which operates without the interference of a third party and differs from fiat currencies where verification is done by a trusted financial institution. All transactions performed by Bitcoin algorithm are recorded on public ledger referred to blockchain.[165]

[162] Naware, p, 1733.
[163] Polasik et al, p.11.
[164] Vasilis Kostakis and Chris Giotitsas , "The (A) Political Economy of Bitcoin",Triple C: Communication, Capitalism & Critique, *Open Access Journal for a Global Sustainable Information Society*, 2014,Vol.12, No. 2, https://triple-c.at/index.php/tripleC/article/view/606 (23 April 2019 ), p.434.
[165] Conti, et al, p. 8.

Bitcoin offers a platform which is transparent and public, thus anyone is able to follow and see the chain of transactions performed so far.[166] Bitcoin is an open source project which makes the transaction process to be transparent to all and helps transparency while creating new coins.[167] The open source code of Bitcoin let people to develop Bitcoin services and create applications easy and flexible.[168]

Bitcoin provides anonymity to the user who has an option to change the wallet address for each transaction to provide a second step anonymity in the transaction.[169] The ability of Bitcoin to make its transactions both transparent and anonymous at the same time facilitates the popularity and use of Bitcoin as a currency.[170]

#### 3.6.6. Non-inflationary Ability

Inflation is the increase in the prices of the goods and services within a particular period. Inflation is a feature of traditional currency and it causes the currency to lose its value.[171] Inflation is controlled by the government or the central bank via monetary policies.

Bitcoin could be a solution to this phenomenon. As mentioned earlier, Bitcoin has a limited supply of coins which is 21 million, and it is a decentralized currency. The system of Bitcoin is deliberately set as it is in order to combat inflation which is mostly associated with traditional currency. Bitcoin was created to be free of central control, thus inflation rate and supply of the currency are determined by the miners publicly. Therefore, Bitcoin will not be exposed to high inflation rates like the fiat currency.

### 3.7. Disadvantages of Bitcoin as a Currency

There are also some other drawbacks of Bitcoin when compared to fiat currencies. Here these disadvantages will be discussed.

[166] Kancs, et al, p. 9.
[167] Kostakis, p. 434
[168] Kostakis, p. 434
[169] European Central Bank, Virtual Currency Schemes, October 2012, p. 23.
[170] Kancs, et al, p. 9.
[171] Kancs, et al, p. 13.

### 3.7.1. High Volatility Rate

Bitcoin has fluctuation in its market price and these could be rather sudden and very sharp. For example, the prices of Bitcoin can change from $10,000 to $5,000 within a space of 24 hours. These fluctuations caused some of the vendors and financiers to avoid using it.[172] Because this volatility results in serious losses for some of the owners of Bitcoins. This notion has caused some investors and financiers to become reluctant in investing or using Bitcoin.

### 3.7.2. An Open Field for Criminal Activities

Because the parties of Bitcoin transactions are anonymous it creates an open field for criminals to interact and make payments anonymously.[173] Since the transactions cannot be monitored by third parties, criminal activities such as money laundering, drug trade could not be traced back.

In 2013 the famous black market called Silk Road was closed by law enforcers after it had was realized that there was a lot of drug related payments being made on the Silk Road. This could be possible in fiat money as well in Bitcoin as it was easier to carry out transactions.[174]

### 3.7.3. Limited Accessibility

Although Bitcoin is used as a medium of exchange to make payments for goods and services in many parts of the world, it is hard to say that Bitcoin is accessible to all sorts of payments. Even though there are many vendors and companies who accept Bitcoin payment, there are still many more who are not accepting payments via Bitcoin.[175]

The limited accessibility of Bitcoin is effectual particularly in areas where internet access is limited, for example, Africa, Asia and South America. Since Bitcoin relies on internet and CPU power to operate and for the transactions to be completed, their absence reduces the number of people who can use Bitcoin.

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[172] Ogunbadewa, p. 22.
[173] Segendorf, p.84.
[174] "Silk Road and Bitcoin", Research Institute for Arts and Humanities Swansea University, 2013, https://www.swansea.ac.uk (28 April 2019), p.2.
[175] Yermack, p. 10.

Furthermore, Bitcoin transactions are rather more complicated than the transactions of fiat money. With fiat money, a person has to make payment with cash or credit cards to complete the transactions. However, with Bitcoin the process is much more complex in its nature, for example, the use of public and private keys as well as digital signatures may not be easy for consumers to be understood with ease.

### 3.7.4. Cyber Attacks

In terms of fiat currency, there is a threat to be stolen physically by thieves. Although it is not possible for Bitcoin, it can still be robbed by means of cyber-attacks particularly hacking.[176] Since Bitcoin are stored on wallets in digital form, usually, hackers try to steal Bitcoins from the merchants, the trading platforms and well as the common users.[177]In addition to the cyber-attacks, there is a danger of the Bitcoin wallets being hacked or infected by computer viruses[178] which may cause those Bitcoins unclaimed by anyone.

[176] Polasik et al, p.19.
[177] Polasik et al, p.19.
[178] Kostakis, p. 432.

# IV. ECONOMETRICAL ANALYSIS OF BITCOIN

## 4.1. Introduction

The relationship between Bitcoin and three economic indicators will be explored in this section. These three economic indicators include Crude Oil Price per barrel ($), Gold price per ounce ($), and Euro/Dollar exchange rate.

The Vector Autoregressive Model was used to investigate the relationship between Bitcoin and Gold, Crude Oil and Euro/Dollar exchange rate based on 151-week data of 2016-2018 period, and the direction of the relationship between the variables was determined by Granger causality test.

In this study, all the analysis are performed by using the software of Eviews 10.

## 4.2. Methodology

In this part, the methods which are used to choose the right model to investigate the relationship between Bitcoin, Gold Price, Crude Oil Price and Euro/Dollar exchange rate. If these variables are all stationary, an ordinary time series analysis might be appropriate, however if they are non-stationary a cointegration analysis, Vector Error Correction model or Vector Autoregressive model might be the suitable model to test this relationship. Therefore, this part starts with explaining stationarity tests.

Addition to stationarity, the correlation between independent variables is another factor that should be taken into account to determine the appropriate model. Therefore multicollinearity is also explained in this part of the paper. Heteroskedasticity, serial correlation and normality assumptions are some other factors, which are checked for diagnostics of the regression results. They are also explained briefly in this part of the paper. The methodology part ends up by representation of VAR model and Granger Cauasality test.

### 4.2.1 Stationarity Test

Its stationarity is one of the most critical features of time series data. It is feasible to conclude with a "spurious regression" with a non-stationary information, the findings of which could extremely mislead the inferences about the relationship among Bitcoin, Gold Price, Crude Oil Price and Euro/Dollar exchange rate. On the other hand, having non-stationary data does

not always mean that the relationship between these variables causes spurious regression. If the variables are cointegrated in their level form, the regression results will show their long-run equilibrium relationship.

Therefore, the first step to start analyzing the time series is to determine the variables ' stationarity. There are three conditons for covariance stationarity.

1) $E(y_t)=\mu$, The variable should have constant mean.
2) $Var(y_t)=\sigma^2$, The variable should have constant variance.
3) $Cov(y_t,y_{t-s})=\rho_s$, The covariance between two periods of variable does only depends on s.

There are several methods to test whether the variables satisfy all of the three conditons of stationarity. One of the ways to test stationarity of variables is unit root test. The presence of unit root is an evidence for non-stationarity. There have been intended many separate unit root tests. Augmented Dickey Fuller Unit Root test obtained from Dickey Fuller Test is used in this research.

In the conventional Dickey-Fuller test the following 3 equaitons can be run.

$$\Delta y_t = \beta_1 * y_{t-1} + u_t \quad (1)$$

$$\Delta y_t = \beta_0 + \beta_1 * y_{t-1} + u_t \quad (2)$$

$$\Delta y_t = \beta_0 + \beta_1 * y_{t-1} + \beta_2 * Trend + u_t \quad (3)$$

While the first test called as unit root test with no drift and trend, the second test is unit root test with drift and the third test is unit root test with drift and trend. In all of the three test the hypothesis are as following.

$H_0$: $\beta_1 = 0$ ,The variable does have unit root, the variable is not stationary

$H_1$: $\beta_1 < 0$ ,The variable does not have unit root, the variable is stationary

Although we can determine the stationarity of variables with Dickey -Fuller Test as described above. Dickey-Fuller Test results might be misleading in the presence of serial

correlation. When serial correlation exists, the Dickey fuller Test indeferences about the stationarity of the variable can be misleading. So the error term u was considered to be uncorrelated in the Dickey-Fuller Tests. However if the u are correlated, another test, known as the Augmented Dickey – Fuller (ADF) test, was created by Dickey and Fuller. Serial correlation in error terms should be controlled in the unit root tests. Augmented Dickey Fuller test solves this problem by adding lagged differences of the variable into the unit root test equaiton. The Augmented Dickey Fuller uses the following tests to determine the stationarity of the variable.

$$\Delta y_t = \beta_1 * y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta y_{t-i} + u_t \quad (4)$$

$$\Delta y_t = \beta_0 + \beta_1 * y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta y_{t-i} + u_t \quad (5)$$

$$\Delta y_t = \beta_0 + \beta_1 * y_{t-1} + \beta_2 * Trend + \sum_{i=1}^{m} \alpha_i \Delta y_{t-i} + u_t \quad (6)$$

While the first test does not include drift, the second test includes drift and the third test included both trend and drift. Same as in the Dickey-Fuller Test, in Augmented Dickey - Fuller tests the hypothesis are as following.

$H_0$: $\beta_1 = 0$ ,The variable does have a unit root, the variable is not stationary

$H_1$: $\beta_1 < 0$ ,The variable does not have unit root, the variable is stationary

### 4.2.2 Multicollinearity

Multicollinearity is another problem that will threaten the reliability of the results of econometric analysis. Multicollinearity can be defined as high correlation between two or more independent variables[179]. Multicollinearity causes regression coefficients, although determinate, to possess large standard errors. This indicates that it is not possible to predict the coefficients with great precision or accuracy. As a result, although multicollinearity does not threaten the unbiasedness of the estimates of the regression, by causing high standard errors, large variance, multicollinearity decreases t-statistics and might make the variables seem statisticaly insignificant even they might be actually significant[180].

[179] Jeffrey Wooldridge, Introductory Econometrics,4th ed, U.S.A: South Western Cengage Learning,2014 p. 84.
[180] Damodar Gujarati, Basic Econometrics,5th ed, U.S.A: Tata McGraw-Hill Education Pvt. Ltd, 2013, p.327.

Multicollinearity can be detected by two ways. Variance Inflationary Factors (VIF) is one of the methods to check multicollinearity. It demonstrates how much an estimator's variance is inflated by multicollinearity.[181] A VIF score higher than 10 suggests that multicollinearity exists in that model. VIF method allows us to check collinearity more than two variables.

Correlation matrix is another way to find out whether multicollinearity exists. Pair-wise correlation is given by Correlation matrix. If the correlation between two independent variables of the model is higher than 90%, multicollinearity problem will be valid in that model.

### 4.2.2 Heteroskedasticity

One of the critical assumptions of the classical linear regression model is homoskedasticity assumption. According to this assumption the variance of each disturbance term is equal to a constant $\sigma^2$. [182] If the variance of each disturbance term is not constant, then it is said that the error terms are heteroskedastic. Actually, the variance of u, homoscedastic or heteroscedastic, does not, play a role in determining the unbiased property. Regardless of heteroskedasticity, the regression estimates are unbiased, however in the presence of heteroskedasticity t and F statistics will likely offer us improper outcomes, therefore when heteroskedasticity exists the inferences about significance are not reliable. For this reason in the study, heteroskedasticity of the error terms are tested before interpreting the regression results.

### 4.2.3 Serial Correlation

In a time series, serial correlation is described as correlation between the errors in different time periods.[183] As in the case of heteroscedasticity, even if autocorrelation is present, the OLS estimators are still unbiased, consistent and asymptotically normally distributed. However, heteroskedasticity causes OLS estimators to become inefficient. [184] In the presence of heteroskedasticity the calculated variance is likely to be higher than the true population variance. Therefore, the significance inferences based on t and F tests are no longer valid. If

[181] Gujarati, p. 328.
[182] Gujarati, p. 374.
[183] Wooldridge, p.767.
[184] Gujarati, p. 423.

these tests are used despite heteroskedasticity are very likely to cause misleading inferences about the significance of variables. [185]

Lagrange Multiplier (LM) Test is one of the methods to check whether serial correlation exists is error terms of the regression. The LM test is conducted in this research to determine whether there is a serial correlation.

### 4.2.4 Vector Autoregressive Model

The possibility of endogenity might make conventional multiple linear model estimates biased. At that point, Vector Autoregressive (VAR) Model is an appropriate model designed to deal with endogenity problems. In the VAR model all of the variables are handled as endogenous and their effect on each other are accounted. In these models, for each variable, an equation is generated. In these equations, each variable become dependent variable and the dependent variable's lagged values and independent variables' lagged values added to the equation. At the end there will be as many equations as number of variables. So that each variable's effect on other variables can be tested. The VAR model, for two variables, will use the following systems of equations.

$$Y_t = \alpha_0 + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{i=1}^{m} \beta_i X_{t-i} + u_t \quad (7)$$

$$X_t = \alpha_0 + \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{i=1}^{m} \beta_i X_{t-i} + u_t \quad (8)$$

The VAR analysis require to determine optimal lag length. In the equations above m refers to optimal lag. The appropriate lag length is chosen depending on information criterias. The information criterias used in this study are Likelihood Ratio (LR) statistics, Final Prediction Error (FPE), Hannan-Quenn (HQ) , Schwarz (SIC), Akaike (AIC). The lower the model's information criteria, the more appropriate the lag length used in that model. However, solely information criteria is not enough to decide on optimal lag length. Serial correlation is a very critical problem in VAR analysis, because VAR model includes the lagged value of dependent variable. Therefore, before determining optimal lag, the model results with that lag should be

[185] Gujarati, p.424.

tested in terms of serial correlation. The appropriate lag length can only be selected after finding that the error terms are not serially correlated.

### 4.2.5 Granger Causality Test

In the regression analysis, the study of interest is the dependence of one variable on other variables. However this does not always imply that there is causation between these variables. In other words, causality or the direction of influence cannot be proved by the existence of a relationship among variables.[186]

The Granger causality test consists of estimating the following systems of regressions[187]:

$$Y_t = \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{i=1}^{m} \alpha_i X_{t-i} + u_t \quad (9)$$

$$X_t = \sum_{i=1}^{m} \gamma_i X_{t-i} + \sum_{i=1}^{m} \delta_i X_{t-i} + u_t \quad (10)$$

By using these models Granger Causality test finds out not only the significance of the relationship between variables but also the direction of the relationship between these variables.

## 4.3 Empirical Findings

### 4.3.1 Multicollinearity

The detection of multicollinearity is performed by using correlation matrix and VIF. The following table demonstrates the correlation matrix which shows pair-wise correlation between independent variables.

**Table 1.Correlation Matrix**

| | LOG_EURO | LOG_GOLD | LOG_OIL |
|---|---|---|---|
| LOG_EURO | 1 | 0.66 | 0.50 |
| LOG_GOLD | 0.66 | 1 | 0.35 |
| LOG_OIL | 0.50 | 0.35 | 1 |

[186] Gujarati, p.652.
[187] Gujarati, p.653.

The pair-wise correlation between variable verifies that there is no multicollinearity in the model, because none of the correlation between variables is greater than 90%. On the other hand correlation matrix only illustrates correlation between two variables. This does not mean that correlation between three variables does not cause multicollinearity. VIF method takes into the consideration the fact that correlation among more than two variables may cause multicollinearity. Therefore, VIF scores is also used to decide whether multicollinearity exists. VIF score of the independent variables are shown in the table below.

**Table 2.Variance Inflationary Factors**

| | Coefficient | Centered |
|---|---|---|
| Variable | Variance | VIF |
| LOG_EURO | 1.935793 | 2.123325 |
| LOG_GOLD | 1.278151 | 1.810654 |
| LOG_OIL | 0.055062 | 1.345213 |

VIF scores also confirms that there is no multicollinearity problem in the model, because none of the VIF scores are greater than 10.

### 4.3.2 Unit Root Tests

Table 3 and Table 4 shows the ADF test statistics. Table 3 demonstrates the t values of ADF test that applied to level form whereas Table 4 demonstrates the t values of ADF test that applied to first difference form.

**Table 3.Unit Root Tests for Level Form of Variables**

| | ADF Test-Level Form | | |
|---|---|---|---|
| variables | None | Intercept | Trend and Intercept |
| LogBitcoin | 1.21 | -1.28 | -0.41 |
| LogGold | 0.66 | -3.34** | -3.19* |
| LogEuro | -0.18 | -1.56 | -1.52 |
| LogOil | 0.54 | -2.23 | -1.5 |

*, **, *** show the significance level at 10%, 5% and 1% respectively.

The ADF test for the level form of the variables suggests that only logarithm of Gold Price is stationary at its level form. Because at 5% significance level, the null hypothesis that logarithm of Gold Price is not stationary should be rejected in the ADF test with intercept. So it can be concluded that logarithm of Gold Price is I (0). To decide whether the other variables

are I (1) or I (2), the ADF test for the first difference of logarithm of Bitcoin Price, Euro/Dollar exchange rate and Crude Oil Price is performed.

**Table 4.Unit Root Tests for the First Difference of Variables**

| | ADF Test-First Difference Form | | |
|---|---|---|---|
| variables | None | Intercept | Trend and Intercept |
| LogBitcoin | -12.90*** | -13.06*** | -13.20*** |
| LogEuro | -12.31*** | -12.28*** | -12.27*** |
| LogOil | -11.32*** | -11.34*** | -11.60*** |

*, **, *** show the significance level at 10%, 5% and 1% respectively.

The ADF test results show that logarithm of Bitcoin Price, Euro/Dollar exchange rate and Crude Oil Price are stationary at their first difference form. The null hypothesis that they have unit root should be rejected even at 1% significance level in three form of the ADF test. It can be concluded that these three variables are I (1)

By running ADF two main conclusions are reached. Firstly, it is seen that our data consists of both stationary and non-stationary data. Non-stationary data cannot be used in the model if there is no cointegration among the variables. Secondly, the first condition to look for cointegration among the variables is that all the variables should have the same order of integration, however ADF test indicates that this is not the case. Therefore cointegration relationship is also not possible among the variables including Bitcoin Price, Gold Price, Crude Oil Price and Euro/Dollar exchange rate. Stating that the variables do not have any cointegrating vector, one of the way to investigate the relationship among these variables is making non-stationary variables stationary. After taking the first difference of Bitcoin, Euro/Dollar Exchange rate and Crude Oil Price, a VAR model can be run with all of the 4 stationary variables.

### 4.3.3 Diagnostics and Regression Results of VAR Model

#### 4.3.3.1 Lag Length Selection

The first step to run the VAR model is determining appropriate lag length. In the following table the information criteria statistics of models with lags up to 8 are illustrated.

**Table 5.Information Criterias to Select Lag Length**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | 1081.864 | NA | 5.03e-12 | -14.66482 | -14.58344 | -14.63175 |
| 1 | 1237.272 | 300.2434 | 7.54e-13* | -16.56152* | -16.15466* | -16.39621* |
| 2 | 1249.444 | 22.85368 | 7.95e-13 | -16.50944 | -15.77709 | -16.21188 |
| 3 | 1258.420 | 16.36469 | 8.76e-13 | -16.41388 | -15.35604 | -15.98406 |
| 4 | 1273.315 | 26.34581* | 8.91e-13 | -16.39885 | -15.01552 | -15.83679 |
| 5 | 1285.587 | 21.03658 | 9.41e-13 | -16.34812 | -14.63930 | -15.65381 |
| 6 | 1291.576 | 9.941822 | 1.08e-12 | -16.21192 | -14.17761 | -15.38536 |
| 7 | 1300.586 | 14.46545 | 1.20e-12 | -16.11682 | -13.75703 | -15.15801 |
| 8 | 1310.847 | 15.91443 | 1.31e-12 | -16.03874 | -13.35345 | -14.94768 |

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The information criteria statistics suggests that the appropriate lag length is 1, because 4 out of 5 types of information criterias chose the model with lag 1 as the appropriate model. However it should be also checked whether the model with 1 lag suffers from serial correlation.

The LM serial test results of the VAR model with lag 1 is as following.

**Table 6.LM Serial Correlation Test for VAR Model with Lag 1**

| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
|---|---|---|---|---|---|---|
| 1 | 26.88316 | 16 | 0.0428 | 1.704941 | (16, 434.5) | 0.0428 |
| 2 | 22.63928 | 16 | 0.1237 | 1.428843 | (16, 434.5) | 0.1238 |
| 3 | 28.09560 | 16 | 0.0308 | 1.784308 | (16, 434.5) | 0.0308 |
| 4 | 21.07921 | 16 | 0.1755 | 1.328014 | (16, 434.5) | 0.1756 |
| Null hypothesis: No serial correlation at lags 1 to h | | | | | | |
| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
| 1 | 26.88316 | 16 | 0.0428 | 1.704941 | (16, 434.5) | 0.0428 |
| 2 | 43.86644 | 32 | 0.0789 | 1.388858 | (32, 510.5) | 0.0791 |
| 3 | 68.00056 | 48 | 0.0302 | 1.445374 | (48, 518.2) | 0.0305 |
| 4 | 94.12797 | 64 | 0.0084 | 1.514303 | (64, 511.2) | 0.0087 |

The LM test claims that there is serial correlation in error terms, because the p-value of LM statistics at lag 1 is 0,0428 which is less than 5%. The null hypothesis that no serail correlation at lag 1 should be rejected. Although information criteria propose optimal lag length as 1, because of the serial correlation, the model with lag 1 cannot be chosen.

One of the information criterias, LR statistics, suggests that optimal lag should be 4. After finding out that 1 cannot be optimal lag, we choose LR statistics' suggestion and test whether there is serial correlation if the model with lag 4 is selected.

The LM serial test results of the VAR model with lag 4 is as following.

**Table 7.LM Serial Correlation Test for VAR Model with Lag 4**

| Null hypothesis: No serial correlation at lag h | | | | | | |
|---|---|---|---|---|---|---|
| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
| 1 | 24.32005 | 16 | 0.0827 | 1.539956 | (16, 388.6) | 0.0828 |
| 2 | 15.46855 | 16 | 0.4906 | 0.968489 | (16, 388.6) | 0.4908 |
| 3 | 12.89390 | 16 | 0.6805 | 0.804651 | (16, 388.6) | 0.6806 |
| 4 | 23.31257 | 16 | 0.1056 | 1.474265 | (16, 388.6) | 0.1057 |
| Null hypothesis: No serial correlation at lags 1 to h | | | | | | |
| Lag | LRE* stat | df | Prob. | Rao F-stat | df | Prob. |
| 1 | 24.32005 | 16 | 0.0827 | 1.539956 | (16, 388.6) | 0.0828 |
| 2 | 37.94561 | 32 | 0.2166 | 1.195565 | (32, 455.2) | 0.2171 |
| 3 | 48.67826 | 48 | 0.4455 | 1.016184 | (48, 460.4) | 0.4471 |
| 4 | 73.94873 | 64 | 0.1852 | 1.168444 | (64, 452.5) | 0.1877 |

The LM test argues that in error terms there is no serial correlation, because none of the p-values of LM statistics is less than 5%. The null hypothesis that no serial correlation at lags 1 to 4 should not be rejected. Because the p-value of LM statistics is 0.187 which is even higher than 10% significance level. Therefore the model with lag 4 is chosen as appropriate model for VAR analysis.

#### 4.3.3.2 Heteroskedasticity Test

The significance of VAR estimates will be reliable only if there is no heteroskedasticity in error terms. The VAR residual heteroskedasticity test results are as following.

**Table 8.Heteroskedasticity Test Results**

| Joint test: | | |
|---|---|---|
| Chi-sq | df | Prob. |
| 358.9115 | 320 | 0.0660 |

The heteroskedasticity test results suggest that the null hypothesis that the residuals are homoskedastic should not be rejected. Because the p-value of Chi-Square statistics is 0.066 which is greter than 5% significance level.

#### 4.3.3.3. Normality Test

Normality in error terms is also checked as a diagnostic test for VAR model regression results. Jarqua-Bera Method is used to check if the residuals are normality distributed. The Jarqua Bera test results are as following.

**Table 9.Normality Test Results**

| Component | Skewness | Chi-sq | df | Prob. |
|---|---|---|---|---|
| 1 | -0.120662 | 0.366410 | 1 | 0.5450 |
| 2 | 0.098301 | 0.243190 | 1 | 0.6219 |
| 3 | -0.239623 | 1.445052 | 1 | 0.2293 |
| 4 | -0.332705 | 2.785762 | 1 | 0.0951 |
| Joint | | 4.840414 | 4 | 0.3041 |
| | | | | |
| Component | Kurtosis | Chi-sq | df | Prob. |
| 1 | 3.245223 | 0.378346 | 1 | 0.5385 |
| 2 | 2.773203 | 0.323623 | 1 | 0.5694 |
| 3 | 2.981341 | 0.002191 | 1 | 0.9627 |
| 4 | 3.376422 | 0.891490 | 1 | 0.3451 |
| Joint | | 1.595649 | 4 | 0.8096 |
| | | | | |
| Component | Jarque-Bera | df | Prob. | |
| 1 | 0.744756 | 2 | 0.6891 | |
| 2 | 0.566813 | 2 | 0.7532 | |
| 3 | 1.447243 | 2 | 0.4850 | |
| 4 | 3.677251 | 2 | 0.1590 | |

| | | | | |
|---|---|---|---|---|
| Joint | 6.436063 | 8 | 0.5985 | |

Normality requires to have a symmetric skewness ( a skewness score of 0) and a Kurtosis score of 3. In the first part of Jarqua-Bera Test the skewness of the residuals is tested and the joint test concludes that the null hypothesis that the skewness is 0 should not be rejected, because the p-value of Jarqua-Bera statistics is 0.30.Similarly in the following part of the test Kurtosis is tested and again the null hypothesis that Kurtosis is 3 should not be rejected, because p-value of Jarqua-Bera statistics is 0.81. At the end the null hypothesis that skewness is 0 and kurtosis is 3 is jointly tested, and the results suggest that this null hypothesis should not be rejected. At this time the p-value of test statistics is 0,5985 which is greater than even 10% significance level.

### 4.3.4 VAR Model Estimations

The diagnostic test findings indicate that the VAR model with lag 4 does not suffer from heteroskedasticity, serial correlation and non-normality problems. Therefore, this model can be chosen as appropriate VAR model to investigate the relationship of Bitcoin Price with Gold Price, Crude Oil Price and Euro/Dollar exchange rate. The regression results of the VAR model are as follows. The statistics in brackets are t-statistics while the statistics in parantheses are standart error of estimates. The t-statistics are calculated by dividing the coefficient to standart error of the coeeficient.

**Table 10.Var Model Regression Results**

| | D(LOG_BITCOIN) | D(LOG_EURO) | LOG_GOLD | D(LOG_OIL) |
|---|---|---|---|---|
| D(LOG_BITCOIN(-1)) | -0.073363 | 0.004219 | 0.000799 | -0.001721 |
| | (0.08320) | (0.00685) | (0.01302) | (0.03009) |
| | [-0.88178] | [ 0.61612] | [ 0.06136] | [-0.05720] |
| | | | | |
| D(LOG_BITCOIN(-2)) | 0.013421 | -0.004820 | 0.006017 | 0.042642 |
| | (0.08317) | (0.00685) | (0.01302) | (0.03008) |
| | [ 0.16136] | [-0.70402] | [ 0.46222] | [ 1.41749] |
| | | | | |
| D(LOG_BITCOIN(-3)) | 0.083188 | -0.006757 | -0.010494 | -0.051414* |
| | (0.08058) | (0.00663) | (0.01261) | (0.02915) |
| | [ 1.03232] | [-1.01875] | [-0.83206] | [-1.76400] |

| | | | | |
|---|---|---|---|---|
| D(LOG_BITCOIN(-4)) | -0.110472 | 0.008608 | 0.012778 | 0.029871 |
| | (0.08109) | (0.00667) | (0.01269) | (0.02933) |
| | [-1.36233] | [ 1.28968] | [ 1.00682] | [ 1.01845] |
| | | | | |
| D(LOG_EURO(-1)) | 0.121324 | 0.044467 | 0.087750 | -0.127661 |
| | (1.09866) | (0.09043) | (0.17195) | (0.39737) |
| | [ 0.11043] | [ 0.49170] | [ 0.51033] | [-0.32126] |
| | | | | |
| D(LOG_EURO(-2)) | 1.922895* | -0.047161 | -0.239441 | 0.012803 |
| | (1.07943) | (0.08885) | (0.16894) | (0.39041) |
| | [ 1.78141] | [-0.53079] | [-1.41732] | [ 0.03279] |
| | | | | |
| D(LOG_EURO(-3)) | 1.749067 | -0.100914 | 0.186633 | 0.818102** |
| | (1.08969) | (0.08970) | (0.17055) | (0.39413) |
| | [ 1.60511] | [-1.12507] | [ 1.09433] | [ 2.07573] |
| | | | | |
| D(LOG_EURO(-4)) | 0.894155 | 0.247630*** | 0.275827 | 0.520207 |
| | (1.01596) | (0.08363) | (0.15901) | (0.36746) |
| | [ 0.88011] | [ 2.96115] | [ 1.73469] | [ 1.41568] |
| | | | | |
| LOG_GOLD(-1) | 0.720126 | -0.038080 | 0.886786*** | -0.128037 |
| | (0.60089) | (0.04946) | (0.09404) | (0.21733) |
| | [ 1.19844] | [-0.76990] | [ 9.42945] | [-0.58913] |
| | | | | |
| LOG_GOLD(-2) | -1.013968 | -0.010833 | 0.106613 | 0.054220 |
| | (0.81481) | (0.06707) | (0.12753) | (0.29471) |
| | [-1.24442] | [-0.16153] | [ 0.83601] | [ 0.18398] |
| | | | | |
| LOG_GOLD(-3) | -1.394299* | 0.023111 | -0.120614 | -0.016464 |
| | (0.80365) | (0.06615) | (0.12578) | (0.29067) |
| | [-1.73495] | [ 0.34936] | [-0.95894] | [-0.05664] |
| | | | | |
| LOG_GOLD(-4) | 1.488194** | 0.006634 | 0.031180 | 0.083792 |
| | (0.58051) | (0.04778) | (0.09085) | (0.20996) |
| | [ 2.56360] | [ 0.13883] | [ 0.34319] | [ 0.39908] |
| | | | | |
| D(LOG_OIL(-1)) | -0.069272 | -0.013528 | -0.075510** | 0.160019* |
| | (0.23186) | (0.01908) | (0.03629) | (0.08386) |
| | [-0.29877] | [-0.70881] | [-2.08087] | [ 1.90816] |
| | | | | |
| D(LOG_OIL(-2)) | 0.704666*** | -0.000665 | 0.055283 | -0.005029 |
| | (0.23767) | (0.01956) | (0.03720) | (0.08596) |
| | [ 2.96485] | [-0.03399] | [ 1.48618] | [-0.05850] |
| | | | | |

| | | | | |
|---|---|---|---|---|
| D(LOG_OIL(-3)) | 0.005467 | 0.035489* | 0.033045 | -0.082925 |
| | (0.23982) | (0.01974) | (0.03753) | (0.08674) |
| | [ 0.02280] | [ 1.79780] | [ 0.88041] | [-0.95602] |
| | | | | |
| D(LOG_OIL(-4)) | 0.287674 | -0.020770 | -0.064347* | -0.106013 |
| | (0.22939) | (0.01888) | (0.03590) | (0.08297) |
| | [ 1.25407] | [-1.10002] | [-1.79229] | [-1.27776] |
| | | | | |
| C | 1.442695 | 0.137156 | 0.687034*** | 0.048848 |
| | (1.58026) | (0.13008) | (0.24733) | (0.57156) |
| | [ 0.91295] | [ 1.05443] | [ 2.77785] | [ 0.08546] |
| | | | | |
| R-squared | 0.19 | 0.13 | 0.85 | 0.15 |
| Adj. R-squared | 0.10 | 0.03 | 0.83 | 0.05 |
| Sum sq. resids | 1.82 | 0.01 | 0.04 | 0.24 |
| S.E. equation | 0.12 | 0.01 | 0.02 | 0.04 |
| F-statistic | 2.00 | 1.29 | 46.84 | 1.50 |
| Log likelihood | 119.32 | 496.41 | 399.38 | 272.89 |
| Akaike AIC | -1.36 | -6.35 | -5.06 | -3.39 |
| Schwarz SC | -1.02 | -6.01 | -4.72 | -3.05 |
| Mean dependent | 0.02 | 0.00 | 7.15 | 0.00 |
| S.D. dependent | 0.12 | 0.01 | 0.04 | 0.04 |

*, **, *** show the significance level at 10%, 5% and 1% respectively.

The VAR model regression results suggest that Crude Oil Price and Gold Price have significant effect on Bitcoin Price. According to the results, an increase in Gold Price in prior 4 period positively correlated with current Bitcoin price because the coefficient of Log_Gold is 1.48. This relationship is also significant, because the t-statistics of the coefficient of Log_Gold(-4) is 2.56 which is greater than 1.96 which is the critical t-statistics at 5% significance level. Similarly an increase in Crude Oil Price in prior 2 period positively correlated with current Bitcoin Price because the coefficient of Log_Oil(-2) is 0.70. This relationship is also significant, because the t-statistics of the coefficient of Log_Oil(-2) is 2.96 which is greater than 1.96 which is the critical t-statistics at 5% significance level.

While Gold Price and Crude Oil Price are significant on Bitcoin Price, the Euro/Dollar exchange rate does not seem to have significant effect on Bitcoin Price, none of the lagged values of Euro/Dollar exchange rate is significant on Bitcoin Price at 5% significance level. Additionally, the second, third and forth column of the VAR regression results show that Bitcoin Price does not have any significant effect on Gold Price, Crude Oil Price and Euro,

because none of the lagged values of Bitcoin Price is significant on these variables. The t-statistics of the coefficients of lagged values of Bitcoin Price are always less than the critical t-statistics of 1.96.

### 4.3.5 Granger Causality Test

Granger causality test determines the direction of influence between variables. By using Granger causality direction of relationship can be implied. The Granger Causality test results are indicated in the following table.

**Table 11.Granger Causality Test Results**

| Dependent variable: D(LOG_BITCOIN) | | | |
|---|---|---|---|
| Excluded | Chi-sq | df | Prob. |
| D(LOG_EURO) | 6.348116 | 4 | 0.1746 |
| LOG_GOLD | 9.780185 | 4 | 0.0443 |
| D(LOG_OIL) | 10.35924 | 4 | 0.0348 |
| All | 27.33724 | 12 | 0.0069 |
| | | | |
| Dependent variable: D(LOG_EURO) | | | |
| Excluded | Chi-sq | df | Prob. |
| D(LOG_BITCOIN) | 3.755592 | 4 | 0.4401 |
| LOG_GOLD | 2.063082 | 4 | 0.7242 |
| D(LOG_OIL) | 4.622494 | 4 | 0.3283 |
| All | 12.24750 | 12 | 0.4260 |
| | | | |
| Dependent variable: LOG_GOLD | | | |
| Excluded | Chi-sq | df | Prob. |
| D(LOG_BITCOIN) | 2.054185 | 4 | 0.7258 |
| D(LOG_EURO) | 6.695907 | 4 | 0.1529 |
| D(LOG_OIL) | 9.854564 | 4 | 0.0430 |
| All | 17.78703 | 12 | 0.1223 |
| | | | |
| Dependent variable: D(LOG_OIL) | | | |
| Excluded | Chi-sq | df | Prob. |
| D(LOG_BITCOIN) | 6.665676 | 4 | 0.1546 |
| D(LOG_EURO) | 6.745744 | 4 | 0.1500 |
| LOG_GOLD | 0.657653 | 4 | 0.9564 |
| All | 17.34426 | 12 | 0.1371 |

In the first part of the results whether Gold Price, Crude Oil Price and Euro/Dollar exchange rate Granger Cause Bitcoin Price is tested. The findings claim that Gold Price Granger Causes Bitcoin Price because the p-value of test statistics for Gold Price is 0,0443 which is lower than 5% significance level. Therefore, the null hypothesis that Gold Price does not Granger Cause Bitcoin Price should be rejected. Similarly, the p-value of Crude Oil Price is also less than 5%. Thefore for Crude Oil Price we should also reject the null hypothesis that Crude Oil Price does not Granger Cause Bitcoin Price. As a result, it can be said that Granger Causality test result confirms the finding of VAR analysis. Both of the methods suggest that Crude Oil Price and Gold Price have significant effect on Bitcoin price.

The following part of Granger Causality test results show that Bitcoin does not Granger cause Gold Price, Crude Oil Price or Euro/Dollar exchange rate. Therefore, it can be concluded that the relationship of Bitcoin with Gold Price, Crude Oil Price, Euro/Dollar exchange rate is not a bilateral one.

## V.CONCLUSION

Electronic money or cryptocurrency is a digital currency which does not depend on a "central bank" (decentralised) or a physical token or paper but based on an open source cryptographic techniques represented by block chain data structure. Bitcoin is the first digital currency of the world invented with the purpose of competing on the market with central banks which are responsible for issuing real currency.

This research aims to identify relationship between Bitcoin and three parameters of Crude Oil, Gold and Euro/Dollar exchange rate. The Vector Autoregressive Model was used to investigate the relationship between Bitcoin and Gold, Crude Oil and Euro/Dollar exchange rate based on 151-week data of 2016-2018 period, and the direction of the relationship between the variables was determined by Granger causality test.

Based on the VAR model results, Bitcoin is significantly affected by Crude Oil Price and Gold Price variable and Euro-Dollar exchange rate has no significant effect on Bitcoin Price. VAR results suggest that an increase in current Gold Price will significantly increase Bitcoin Price in 4 weeks. Seys (2016) also finds this positive relationship and he attributes this positive correlation to the fact that Bitcoin is also is a "safe haven" for investors as Gold. Because these two investments are "safe haven" for investors they should follow the same road[188]. Similarly, the findings of the paper also suggest a positive relationship between Crude Oil Price and Bitcoin, too. However, Atems, Kapper and Lam (2015) showed that shocks in the Crude Oil price provoke asymmetric price changes in Bitcoin Price[189]. Moreover, Palombizio and Morris (2012) also claim that the price of oil is an early measure of inflation rate movement. This could result in a price level change and eventually depreciate the Bitcoin price. [190].

[188] Jens Seys, "The Evolution of Bitcoin Price Drivers: Moving Towards Stability?", 2016, University Of Ghent, https://lib.ugent.be/fulltxt/RUG01/002/273/510/RUG01-002273510_2016_0001_AC.pdf (28 August 2019) ,p.34.

[189]Bebonchu Atems, Devin Kapper and Eddery Lam, " Do exchange rates respond asymmetrically to shocks in the crude oil market?", *Energy Economics*, 2015, Vol. 49, Issue C, https://www.sciencedirect.com/science/article/pii/S0140988315000547 (28 August 2019), p.229.

[190] Ennio Palombizio and Ian Morris, "Forecasting Exchange Rates using Leading Economic Indicators", *Open Access Scientific Reports*, 2012,Vol.1,No.8, https://www.omicsonline.org/scientific-reports/2168-9458-SR-402.pdf (28 August 2019),p.3.

The Granger Causality tests confirm the findings of VAR analysis. Granger Causality results claim that both Gold Price and Crude Oil Price Granger cause Bitcoin Price while Euro/Dollar exchange rate does not Granger Cause Bitcoin Price.

The implication of this study is that the investors of Bitcoin should carefully follow the price changes in Crude Oil and Gold. According to the findings of this study, Bitcoin investors should buy Bitcoin if they observe price increases in Gold and Crude Oil. That is to say, decreases in Gold and Crude Oil Price are signs for Bitcoin investors to sell their Bitcoin investments not to suffer from decreasing value of Bitcoin in the coming weeks.

Since this study tends to examine the relationship of Bitcoin with only 3 indicators, it has several limitations. Future studies should focus on relationship of Bitcoin with other financial variables such as S&P 500, World GDP and also with strong international currencies which were not used in the research. For further researches, the S&P 500 index, World GDP and some other international currencies can also be added to the model to explain changes in Bitcoin prices better.

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