

DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS
ECONOMICS PROGRAM
MASTER’S THESIS

BITCOIN vs GOLD PRICE: A CAUSALITY ANALYSIS

Can ÇAYIR

Supervisor
Assoc. Prof. Dr. Burçak Müge VURAL

İZMİR-2021

THESIS APPROVAL PAGE



DECLARATION

I hereby declare that this master's thesis titled as **“Bitcoin vs Gold Price: A Causality Analysis”** has been written by myself in accordance with the academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resources in the reference list. I verify all these with my honour.

Date

...../...../.....

Can ÇAYIR

Signature

ABSTRACT

Master's Thesis

BITCOIN VS GOLD PRICE: A CAUSALITY ANALYSIS

Can ÇAYIR

Dokuz Eylül University

Graduate School of Social Sciences

Department of Economics

Economics Program

After the year 2008 when Bitcoin was proposed to the financial world for the first time, the financial world was in a desperate turmoil facing with the biggest financial crisis the world has experienced from the time of Great Depression. There was a general negative reaction to banks which are seen as institutions that have triggered the crisis. The confidence to those kind of institutions such as central banks and private monetary institutions such as banks were at all time low.

Bitcoin, however was an alternative solution to the traditional financial world with trusted central third party authorities. This newly invented alternative method of payment is composed of a blockchain system which is a peer to peer network with a decentralized structure. Moreover, the money supply can not be altered in bitcoin ecosystem because there is no central authorities.

The purpose of this study is to analyse causal relationship between Bitcoin and Gold, Bitcoin Transaction Volume, Japanese Yen and Chinese Yuan. Because gold has Bitcoin characteristics such as limited supply and Bitcoin is popular and widely used in countries such as Japan and China; Gold, Yuan and Yen were chosen as variables. In order to test these relationships Continuous Wavelet Transformation Technique is employed with daily data from 28.04.2013 to 19.10.2018. The results have shown that there is a causal out of phase relationship from bitcoin to Yen and gold from 2014 3rd quarter to 2015 2nd quarter, a causal out of phase relationship from bitcoin to Yuan in

2018 1st and 2ndquarter and an in phase relationship from bitcoin to transaction volume in 2017. Furthermore, according to test results there is also an out of phase relationship from Yen to bitcoin in the period 2015 3rd quarter-2018 1st quarter, an out of phase relationship from gold to bitcoin in 2016 1st quarter-2017 3rd quarter, an in phase relationship from transaction volume to bitcoin in 2016 and finally an out of phase relationship from Yuan to Bitcoin in the year 2017.

Keywords: Bitcoin, Blockchain, Cryptocurrencies, Causality, Continuous Wavelet Transformation



ÖZET

Yüksek Lisans Tezi

BİTCOİN İLE ALTIN ARASINDAKİ NEDENSELLİK ANALİZİ

Can ÇAYIR

Dokuz Eylül Üniversitesi

Sosyal Bilimler Enstitüsü

İngilizce Ekonomi Anabilim Dalı

İngilizce Ekonomi Programı

Bitcoinin finansal dünyaya ilk kez tanıştırıldığı 2008 yılında finansal dünya Büyük Buhran'dan beri karşılaşılan en büyük finansal krizle yüzleşir bir durumda ve çaresiz bir hengame içindeydi. Krizi tetikleyen kurumlar olarak görülen bankalara karşı olumsuz bir tepki söz konusuydu. Merkez bankaları ve bankalar gibi özel parasal kurumlara karşı olan güven seviyesi tüm zamanların en düşüğündeydi.

Oysaki bitcoin güvenilen merkezi üçüncü taraf otoritelerine sahip olan geleneksel finansal dünyaya alternatif bir çözümdü. Bu yeni geliştirilmiş alternatif ödeme sistemi uçtan uca merkeziyetsiz bir yapı olan blokzincir sisteminden oluşmaktaydı. Başka bir deyişle güvenilir üçüncü bir kuruma dayanmamaktaydı. Sistemin kullanıcıları başka bir aracı olmadan birbirlerine fon gönderip alabilmekteydiler. Bitcoin para arzı ekosisteminde merkezi bir otorite olmadığı için değiştirilememekteydi.

Bu çalışmanın amacı Bitcoin ile Altın, Japon Yen'i, Çin Yuan'ı ve Bitcoin işlem hacmi arasındaki nedensellik ilişkisini analiz etmektir. Altının kısıtlı arz gibi Bitcoin özelliklerine sahip olması ve Çin ve Japonya gibi ülkelerde Bitcoinin popüler ve kullanımının yaygın olması sebebi ile Altın, Yen ve Yuan değişken olarak seçilmiştir. Bu ilişkileri test etmek için 28.04.2013'ten 19.10.2018'e kadar olan günlük veri kullanılarak Sürekli Dalgacık Dönüşümü Tekniği uygulanmıştır. Alınan sonuçlar Bitcoin'den Yen'e ve Altına 2014 yılı 3. çeyrekte 2015 yılı 2. çeyreğe kadar olan dönemde ters yönlü, Bitcoin'den Yuan'a 2018 1. ve 2. çeyrekte ters yönlü ve Bitcoin'den işlem hacmine 2017 yılı

içerisinde doğrusal bir nedensellik ilişkisi bulunduğunu göstermiştir. Bunun yanında, Yen'den Bitcoin'e 2015 3. çeyrekte 2018 1.çeyreğe ters yönlü, altından Bitcoin'e 2016 1. çeyrekte 2017 3. çeyreğe kadar olan dönemde ters yönlü, 2016 yılı içerisinde işlem hacminden Bitcoin'e doğrusal ve son olarak da Yuan'dan Bitcoin'e 2017 yılı içerisinde ters yönlü nedensellik ilişkisi olduğu saptanmıştır.

Anahtar Kelimeler: Bitcoin, Blokzincir, Kriptopara, Nedensellik, Sürekli Dalgacık Dönüşümü



BITCOIN vs GOLD PRICE: A CAUSALITY ANALYSIS

TABLE OF CONTENTS

THESIS APPROVAL PAGE	ii
DECLARATION	iii
ABSTRACT	iv
ÖZET	vi
TABLE OF CONTENTS	viii
ABBREVIATIONS	x
LIST OF TABLES	xi
LIST OF FIGURES	xii
LIST OF APPENDICES	xiii
INTRODUCTION	1

CHAPTER ONE MONEY

1.1.	TYPES OF MONEY	3
1.1.1.	Commodity Money	3
1.1.2.	Fiat Money	4
1.1.3.	Digital Money	5
1.1.4.	Virtual Money	6
1.2.	FUNCTIONS OF MONEY	7
1.2.1.	Store of Value	7
1.2.2.	Medium of Exchange	10
1.2.3.	Unit of Account	13
1.3.	SALABILITY OF MONEY	14
1.3.1.	Salability	14
1.3.2.	Stock To Flow Ratio	16
1.3.3.	Acceptability	18
1.3.4.	Sound Money vs Unsound Money	19

CHAPTER TWO
BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND BITCOIN

2.1.	GENERAL OVERVIEW	24
2.2.	BLOCKCHAIN TECHNOLOGY	25
2.3.	BITCOIN	32
	2.3.1. Definition Of Bitcoin	33
	2.3.2. Bitcoin Ecosystem	35
	2.3.2.1. Miners	35
	2.3.2.2. E Wallets	36
	2.3.2.3. Exchanges	38
	2.3.3. Aspects of Bitcoin	40
	2.3.3.1. Financial Freedom	41
	2.3.3.2. Limited Money Supply	42
	2.3.3.3. Peer to Peer Transactions and Distributed Ledger Technology	43
	2.3.3.4. Pseudonymity	43
	2.3.3.5. Divisibility	44
	2.3.3.6 Security	44
	2.3.3.7. Fast and Inexpensive 7/24 Wealth Transfer	46

CHAPTER THREE
EMPIRICAL ANALYSIS OF CAUSALITY BETWEEN BITCOIN AND OTHER VARIABLES

3.1.	LITERATURE REVIEW	48
3.2.	DATA AND METHODOLOGY	54
3.3.	EMPIRICAL FINDINGS AND POLICY IMPLICATIONS	58
	CONCLUSION	69
	REFERENCES	73
	APPENDICES	79

ABBREVIATIONS

WWW1	World War 1
U.S.	United States
CB	Central Banks
EFT	Electronic Fund Transfer
BTC	Bitcoin
USD	United States Dollar
VS	Versus
MB	Megabyte
DEA	United States Drug Enforcement Administration
EMD	Empirical Mode Decomposition
FTSE	Financial Times Stock Exchange
VECM	Vector Error Correction Model
CWT	Continuous Wavelet Transform
ICO	Initial Coin Offering

LIST OF TABLES

Table 1: Mining Cost of 1 Bitcoin	p. 36
Table 2: Top 5 Cryptocurrency Exchanges.....	p. 39
Table 3: Descriptive Statistics.....	p. 58
Table 4: Unit Root Test Results	p. 59



LIST OF FIGURES

Figure 1: The First Lydian Coins	p. 4
Figure 2: Types of Virtual Currency Schemes.....	p. 7
Figure 3: Stock to Flow Ratio of Gold, Silver, Oil and Copper	p. 9
Figure 4: The Three Functions of Money	p. 14
Figure 5: Global Gold Stockpiles & Stockpile Growth Rate	p. 22
Figure 6: How does Bitcoin work?	p. 26
Figure 7: Bitcoin Money Supply Growth	p. 28
Figure 8: Cryptographic Transmission	p. 29
Figure 9: How Blockchain Works	p. 31
Figure 10: Reachable Global Bitcoin Nodes.....	p. 32
Figure 11: Exodus Dashboard.....	p. 37
Figure 12: Ledger Nano Hardware Wallet.....	p. 38
Figure 13: Causal Phase Relationship between Bitcoin and Gold.....	p. 60
Figure 14: Causal Phase Relationship between Bitcoin and Japanese Yen	p. 64
Figure 15: Causal Phase Relationship between Bitcoin and Chinese Yuan	p. 66
Figure 16: Causal Phase Relationship between Bitcoin and Transaction Volume	p. 68

LIST OF APPENDICES

APPENDIX 1: Descriptive Statistics and Unit Root Test Results.....	app p. 80
--	-----------



INTRODUCTION

The last global crises started in 2008 had severe effects on global economy leading to stagnations and recessions all around the world. Besides, unemployment levels increased drastically in some countries as a result of economic recessions. Banks, however were the main actors of the global financial crises(Ammous, 2018: 162). Most of the banks in United States took advantage of giving sub prime mortgages to those who have low or inadequate credit scores leading to crises at the end.

Bitcoin's invention and proposal was in the aftermath of the global financial crises which was not a coincidence indeed. After the crises, the general attitude of individuals towards banks were so low that most of the citizens were blaming banks for being the major reason of crisis. The traditional, so called financial, institutions were being questioned and highly debated all over the world. People used to have great suspect about the financial system and they were questioning financial intermediaries such as banks.

Bitcoin was proposed as a peer to peer payment mechanism without third party institutions, like banks. The system is based on blockchain which is a newly invented technology. The main motive for creating such kind of a payment mechanism when there is already one that the whole world was using is the need to eliminate untrusted financial intermediaries(Nakamoto, 2008: 1). By using bitcoin, people will no longer need an approval mechanism. Two parties in distant locations of the world can send and receive bitcoins directly in any time and very fast when compared to Swift system. Besides, the system is pseudonymous such that users do not need to reveal their real personalities.

Ten years after its first introduction to financial world, bitcoin could be regarded as an infant technology at the moment. Despite the huge media attraction due to its tremendous bull run in the year 2017, Bitcoin's fundamentals are not fully understood by most of the investors. So, mostly major investors refrain from investing in bitcoin because they are suspicious of bitcoin's system and its volatile nature. On the other hand despite having a low marketcap and limited usage and adoption, Bitcoin has an important potential to disrupt traditional financial system if it started to be widely used once its inner fundamentals are fully understood(Cai,

2018: 1). On one hand, this potential to disrupt the traditional financial system may bring out Bitcoin to substitute euro, dollar, gold and national currencies. On the other hand, Bitcoin may serve as a critical tool to hedge against risks of oscillations in national currencies and perhaps gold prices. Based on these insights Bitcoin's revolutionary transformation of international financial markets deserves academic interest.

Primary purpose of this research is to reveal the correlation and co-movement structures between Bitcoin and selected medium of exchanges. Because gold has Bitcoin characteristics such as limited supply and Bitcoin is popular and widely used in countries such as Japan and China; Gold, Yuan and Yen were chosen as variables. While testing relationships, daily return series were used taking into account the change in natural log prices such as $Irt = \log (P(t) / P(t-1))$. In the equation $P(t)$ are current prices whereas $P(t-1)$ are previous ones. The research first elaborates money in general sense. Hence, firstly types of money is presented. Afterwards, functions of money are discussed. In addition to that, the term 'salability of money' is explained in detail. In the next chapter, a general understanding of Bitcoin and Blockchain technology is provided. Moreover, the bitcoin ecosystem, actors in bitcoin ecosystem and aspects of bitcoin are explained and elaborated in a deeper manner. Finally, in Chapter 3 Continuous Wavelet Transformation Technique is used for testing the causal relationship between Bitcoin and Bitcoin's Transaction Volume, Gold, Japanese Yen, Chinese Yuan. Furthermore, this chapter includes literature review and empirical analysis.

CHAPTER ONE

MONEY

Before elaborating Bitcoin's resemblance to money, it would be a reasonable approach to understand and analyse money in detail. In this chapter types of money such as commodity money, fiat money, digital money and virtual money will be explained. Afterwards, some information will be given about functions of money such as being a store of value, medium of exchange and unit of account. Finally, salability aspects of money will be discussed such as stock to flow ratio, acceptability, being sound and unsound.

1.1. TYPES OF MONEY

1.1.1. Commodity Money

Commodity money is a type of money deriving its value from the substance which it is made up of such as gold, silver and copper etc. So the intrinsic value of a commodity money is the metal or substance which forms it. The history of money starts with commodity money. First type of payment instruments were commodities. The reason for that is, unlike fiat money that we use today, commodity money has an intrinsic value which was very important for the first primitive users of money. 'In different regions of the world on different times commodity money such as copper, salt, tea, pearl, ivory, neat, iron, slaves and cigarettes etc. had been used as a form of money for thousand years (Çarkacıoğlu, 2016: 1). Besides, as Adam Smith (2007) stated in his famous book *Wealth of Nations* salt in Abyssinia, shells in India, dried cod at Newfoundland, tobacco in Virginia, sugar in Britain's West India colonies, leather in some other countries and nails in Scotland were used as a form of payment instrument. Two most famous commodity money for centuries and even for today is gold and silver. Especially gold supplies are limited. In other words, its additional supply per unit of time has a low proportion to the total stockpile. Hence, gold has a very high stock to flow ratio, which will be explained further in detail. Yet, silver's per unit of supply and production is much more elastic. Among 118 elements in periodic table, those two elements are only ones which are not poisonous, radioactive, flammable, common and which are liquefiable, solid, colourful and

stainless(Çarkacıoğlu, 2016: 2). Lydians were the first nation who printed and used gold as a metal coin. Therefore, they were accepted as the first nation who have found money in today's sense. Figure 1 shows an image of first Lydian's coins made up of gold.

Figure 1: The First Lydian Coins



Source: www.coinweek.com

1.1.2. Fiat Money

Fiat money that is another kind of money as a payment instrument is somewhat different than commodity money because it does not derive its value from the substance which it is made up of such as gold, silver and etc. In other words, fiat money as we use today, has no intrinsic value. Rather, it derives its value from a trust relationship. As Niall Ferguson (2009) stated, unlike precious metals, money should be considered as a trust relationship. This trust mechanism generally originated from the legal tenders, such as central banks (CB) of governments which will be elaborated in the following chapters.

After 17th century, commodity money started to be replaced by fiat money. Despite the fact that it has no intrinsic value, it was pegged to gold so that it has been used to represent some amount of gold. Commercial banks and central banks later were legal tenders forming the mutual trust mechanism. Till World War 1 (WW1), fiat (paper) money was pegged to Gold. However, due to necessity to finance war expenditures and huge costs of war, the governments needed to print money. Yet,

gold resources were limited so they were not able to print money as much as they required. This situation resulted with abandoning of The Gold Standard, which was the state of pegging the paper money to gold.

In 1944, the US Dollar was pegged to gold which is called Bretton Woods System and all other currencies were pegged to Dollar. So, actually in an indirect way all other currencies were pegged to gold in the end. After the abolishment of pegging by United States (U.S.) in 1971, the Gold Standard System has finally ended. Today no currency in the world is pegged to a precious metal such as gold and silver. Technically, if there is no legislation or law limiting the money supply or money printing mechanism, Governments' central banks can inflate money supply by printing as much money as they wanted resulting in inflation. This case generally occurs in countries where central banks have no free decision making process because of government oppression. However, in order to be financially strong in case of negative financial conditions or crises most central banks hold gold reserves and they keep on buying even today.

1.1.3. Digital Money

Digital money is the third form of money which by its definition is the digital form of money, in other words money that is intangible (one can not touch or feel) in some sense. Dwyer (2014) defines digital or electronic money as a storage of value in an electronic medium such as on a card or on a hard disk. When American Banks started to transfer money by electronic means, which is called electronic fund transfer (EFT), the digitalization of money has started (Dilek, 2018: 9). With the help and progression of technological innovations, digitalization process speeded up resulting in some tools such as credit cards, PayPal, electronic check, e-wallets. With the digitalization of money, storing and transferring deposits has become much more easier. Furthermore, there was no need to carry the whole funds physically any more. The transfer process could easily be accomplished just by one click. Besides, not only domestic money but also foreign exchanges and gold could also be stored and transferred digitally. After digitalization, storing money is not a costly process anymore as before it used to be. Just because investors know that they can easily reach their funds in banks and can make transfers with the help of digitalization, they

don't even search ways for storing funds and they deposit their funds to financial institutions much more easily.

Today with the improvements in financial applications people can easily reach their deposits in banks with the help of a small application in their self phones. Most people manage their investment portfolio and execute buy and sell orders with their computers or mobile machines without going to a bank. Furthermore, by using the same tools, they also can accomplish wire transfer or electronic fund transfers with firms such as PayPal or Western Union. Those ease of use and options are all the final results of digitalization of money.

1.1.4. Virtual Money

Virtual money is briefly a form of digital money meaning that it is not in physical shape, rather it is stored electronically in digital wallets. On the other hand, virtual money is a branch of digital money. In another words, all virtual money is digital money but on the other hand all digital money is not virtual money since virtual money is only a part of digital money. By defining virtual money, two important issues are important. The first one is virtual money has no central authority which has an authorization to create money such as central banks, and the second one is virtual money has credibility only because the community who has agreed to use it set some value to that currency(Dulupçu, Yiyit and Genç, 2017: 2242).

As noted above, virtual money is different than fiat money for a reason that the former is not issued by a central authority such as central banks. Instead, virtual money such as cryptocurrencies are produced by solving complex mathematical formulas by the community members who are called miners on blockchain. Besides, there are also no institutions which regulate monetary policy or money supply. Bitcoin (BTC), which is the most popular cryptocurrency or virtual money for instance has a supply algorithm which is planned before and could not be changed by members of bitcoin community.

Virtual Currency can be classified into 3 different groups according to European Central Bank ;

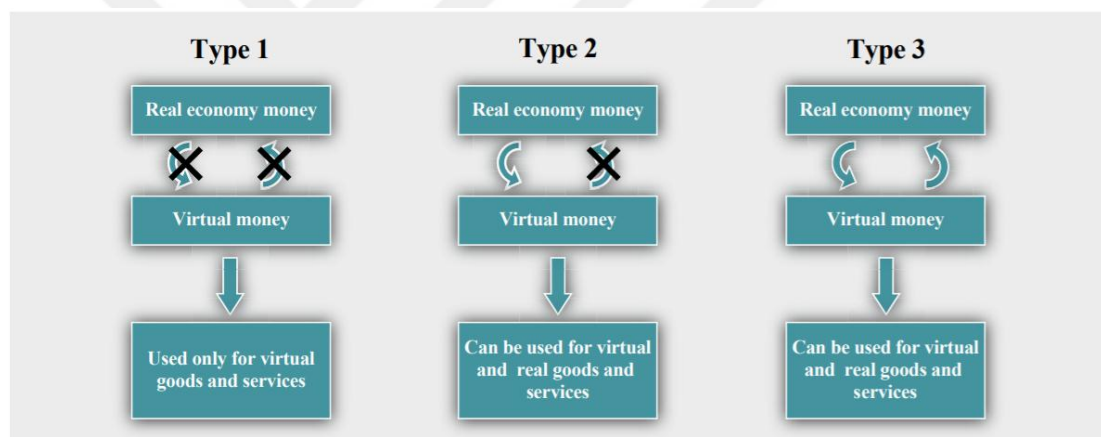
Closed Virtual Currency Schemes (Type 1) which are called 'in game only schemes' have almost no link to the real economy. The virtual currency can only be

spent in order to obtain services in that virtual community such World of Warcraft Gold.

In Virtual Currency Schemes with Unidirectional Flow (Type 2) virtual currency can be purchased with fiat money with an exchange rate, but it can not be converted back to the original currency such as Facebook Credits.

In Virtual Currency Schemes with Bidirectional Flow (Type 3) people can buy and sell back their virtual currency according to an exchange rate such as Linden Dollars, a virtual currency of Second Life which is a virtual world in which users use avatars that can be customised. Furthermore, cryptocurrencies can also be classified into this group. Figure 2 demonstrates the distinction between these 3 types of virtual currency system. (European Central Bank, 2012: 13-14)

Figure 2: Types of Virtual Currency Schemes



Source: European Central Bank

1.2. FUNCTIONS OF MONEY

1.2.1. Store of Value

One of the main functions of money is, it should be an ideal store of value. Indeed, this function of money is the first and the most crucial function that a payment instrument should satisfy in order to be accepted as money. Being a store of value refers to the notion that the payment instrument which is used as money should not lose its value drastically in the long term.

According to Keynes (2003), one's demand for money depends on 4 types of motives which are Income Motive, Business Motive, Precautionary Motive and

finally Speculative Motive. Furthermore, he explains that precautionary motive is the motive to save money and be ready for events requiring sudden expenditure and unforeseen opportunities of advantageous purchases. Besides, according to Keynes (2003) in his famous book *The General Theory of Employment, Interest and money* people demand money for speculative motives which they think they will benefit such as keeping bonds. Both the two motives above are generally related with saving money for future plans and needs. Thus, in order to have a healthy saving mechanism, money should be a good store of value so that it should not lose its value in the long term. If not, people would no longer want to keep that kind of commodity or fiat money neither for precautionary nor for speculative motives.

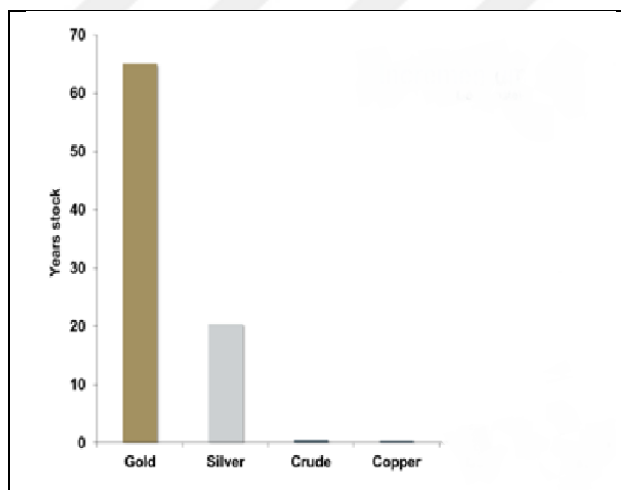
In order for a monetary instrument to be a good store of value, as said above it should not lose its value in the long term. In the market economy even monetary instruments' values are evaluated in terms of their supply and demand levels. Taking into consideration a stable and not volatile demand for money, the crucial criteria which effects the value for the long term is its supply level. So the supply level should be stable so that it should not be inflated artificially. If the supply level changes radically for some reason, that results in a loss of value of that monetary instrument.

Regarding the supply change, a criteria named stock to flow ratio was explained by Saifedean Ammous (2018) in his book '*The Bitcoin Standard.*' The stock to flow ratio which will be explained in next sections is composed of two different parts which are stock and flow. The term stock refers to the whole produced supply minus consumed and destroyed parts and the flow is the additional supply in the next period. In order for a commodity to be a good store of value, its stock to flow ratio should be high in proportion to other alternatives. Those instruments which have low stock to flow ratio would inevitably lose value and become unpopular as a store of value instrument in the long term (Ammous, 2018: 5).

Gold as an example, is known as a good store of value for centuries indicating that it is a good store of value even in the long term. One of the main reason for that is, its supply can not be inflated easily leading to high stock to flow ratio in the long term. The reason for gold's supply can not be inflated easily is, it is hard and costly to mine gold. Despite the innovating technology in searching and

mining sectors, the metal gold remains costly to dig and mine because each day the additional piece of gold becomes harder to reach. Besides, the explained high stock to flow ratio enable gold a higher credibility than other monetary metals and minerals such as silver, oil, and copper. Despite, in some time in the past there had been some use cases of silver and copper as a monetary instrument, in today's economies silver, copper and oil are no longer suitable options for a healthy store of value as a monetary instrument even though they have economic value(Menger, 1892: 1). The main reason for that is neither silver nor oil and copper has high stock to flow ratios (Ammous, 2018: 24). Figure 3 represents gold, silver, oil and copper's stock to flow ratios. As it could be understood from Figure 3, gold's annual production of additional supply is relatively small value in proportion to the total stockpiles leading to high stock to flow ratio whereas silver, oil and copper's additional supplies have high values in proportion to their total supply which lead to low stock to flow ratio. The figure neatly emphasizes gold's importance as a store of value whereas silver, oil and copper have no longer those aspects.

Figure 3: Stock to Flow Ratio of Gold, Silver, Oil and Copper



Source: Incrementum AG

In order for a medium of exchange to be a good store of value it must be non perishable. In other words, it should not be spoiled, oxidated, dissolved or damaged in time. Somehow, if a payment instrument is not immune to those kind of cases, then it is not a good store of value and ends up being worthless because it does not have even the first characteristic of money. So the payment instrument should have

the specification to be stored in a long time. In primitive economies, even though people were very familiar to items related with food such as meat, rice, wheat, corn, the non availability or non suitability of storing in long time intervals was the most important reason for these commodities not to be used as a form of money in the long run.

1.2.2. Medium of Exchange

During centuries, since the invention of money whether it is commodity or fiat, money has some concrete functions such as medium of exchange, store of value and unit of account. These functions have played a crucial role during the history of money. In case of a loss in one of the functions above, the related commodity might no longer serve as a payment instrument.

One of the three functions of money is a medium of exchange. The term medium of exchange relates to the payment function of money. In other words, it is about being a payment instrument. Individuals are able to make trades and exchanges with the help of a 'medium of exchange'. The medium of exchange on the other hand, has to be known and accepted by all members of society meaning that everyone in that commodity should accept that form of money while selling and buying things as a form of payment mechanism. If some parts of community do not accept that form as a payment option then some parts of that society might have hard time spending that medium of exchange. Since this case does not constitute a healthy trade environment, that payment option starts to lose its credibility among society and might fade away.

In ancient primitive societies, before the creation of a healthy medium of exchange like money there were barter economy. People used to exchange goods and services in order to survive. Every individual used to come to market place in order to exchange his excess supply of goods with ones he needs. Taking into consideration of a farmer who grows wheat, he saves some of his wheat for his future needs to feed his family and takes the rest to the marketplace in order to exchange the rest with other goods that he is not able to produce and he thinks he will be in need. But this case, however was very problematic since barter requires coincidences of supply or skills, preferences and time (Szabo, 2002: 6). As an example, in the case

where the farmer needs oranges, he has to find a person who wants to exchange oranges for wheat, in other words there should be coincidence of needs. Another example, this farmer might be in need to find someone to carry his loads of wheat. In that case he has to find a man who is able to carry that load for some wheat. In other words, farmer's needs should coincide with that man's preferences.

Space issue might be another problem for those who trade with barter system. Finding enough space to store excess goods in order to exchange is a serious problem. In the above example, if the farmer needs to sell his excess supply of the whole year crop, he might not find enough area to store.

Furthermore, besides space problem transportation of goods is another problem of barter economy. Carrying the excess supply of goods to exchange is not an easy option even today and in primitive societies this was a more problematic issue because of lack of transportation resources and technology.

Time problem is also another negative issue of barter system since taking into consideration of primitive times and regarding that most of traded goods are food based products, there is a limited time for producers and sellers to sell their products before spoiling and perishing. This situation is especially crucial for foods products which are mostly perishable. Despite of the advanced technology we have, even today it can be hard to preserve agricultural goods. The sellers might have hard time to find a person who has the need that coincide with those seller's before their products perish.

The barter system and its problems were left behind after mankind find other alternative ways of payments. *Over the years a variety of payment media have been used in various contexts. These include:*

- *Commodities*
- *Stones*
- *Precious Metal Coins*
- *Base Metal Coins*
- *Banknotes from private banks*
- *Banknotes issued by governments*
- *Credit and debit cards* (Angel and McCabe, 2014: 4).

The ideal medium of exchange should have a notion of credibility. The term credibility refers to general acceptance and trust for a medium of exchange. Without credibility or in other words trust for that kind of payment, that form of payment becomes useless. The following example of Rai Stones demonstrates how decreasing trust and low credibility lead to drastic value depreciation on the medium of exchange ending up worthless at the end. Rai Stones that were used as a form of payment on Yap Island which is a part of the Federated States of Micronesia would hold no value without credibility in the eyes of the island's citizens. Indeed, after David O'Keefe an Irish-American captain who was shipwrecked on the shores of Yap and revived by the locals started to quarry several large Rai Stones and set sail to Yap to use as a medium of exchange, the Rai Stones started to be less credible day by day ending up being worthless in the end (Ammous, 2018: 12).

Fiat money such as paper money in today's world, physically is only a piece of paper with some ink. Furthermore, it has no intrinsic value because it is not made up of precious metal and it does not have a use case other than being a form of payment. However, it has a real core competence because it is backed by governments. CB of states by being a lender of last resort supply credibility to that 'form of paper with some ink.' With its government backing aspect and by knowing that CB are last resorts, citizens know that their paper money has value. With all individuals thinking and acting the same way and in the same sense, a flawless money mechanism was set upon in between all members of society.

As explained above, with a credible and trustable medium of exchange a flawless payment mechanism emerges. This mechanism, however enables individuals to trade with less effort and in a faster way. Because of the fact that people will no longer search for a person with interests which coincide, trades take place much more easily and conveniently. The new medium of exchange is accepted by all members of society in all types of transaction becoming a catalyzer for transactions and economy.

1.2.3. Unit of Account

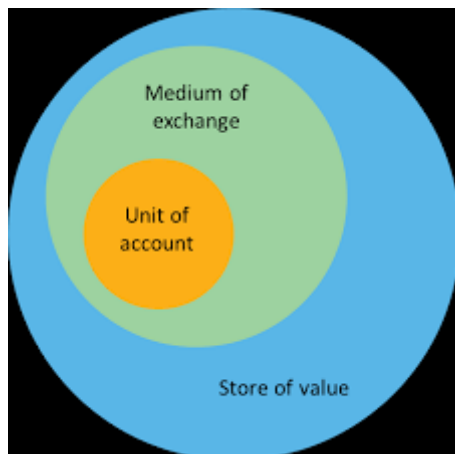
The last but not least important function of money is it is a unit of account. Hence, the term unit of account is maybe the most important function of money since it is at the top according to hierarchical level. In other words, in order for a payment instrument to be a unit of account it should satisfy both the other two functions which are store of value and medium of exchange.

The function of 'unit of account' relates to value of measurement. In other words, money should be a measurement value in the eyes of a societies' members. Hence, such payment instrument as a unit of account should be generally accepted. When someone calls one unit of such commodity the same value of measurement should equally be understood everywhere by all members of society. So, this type of measurement should be agreed upon by everyone. If each unit of value does not make the same sense, like if one unit of such kind of money associates different levels of value then the related payment instrument would not satisfy the function of being a unit of account and start to lose its role as a payment instrument.

The functions of money –store of value, medium of exchange and unit of account- operate in a hierarchy (Figure 4). There are many assets that people view as stores of value -houses, for instance- that are not used as media of exchange. By comparison, an asset can only act as a medium of exchange if at least two people are prepared to treat it as a store of value, at least temporarily. And for an asset to be considered a unit of account, it must be able to be used as a medium of exchange across a variety of transactions over time between several people(Carney, 2018:3).

So as shown in Figure 4, the unit of account function serves as core function of money which could not be satisfied without having the two previous functions such as store of value and medium of exchange. If payment option is regarded as a unit of account then it has already been accepted as a store of value and medium of exchange.

Figure 4: The Three Functions of Money



Source: Carney, 2018: 4.

1.3. SALABILITY OF MONEY

1.3.1. Salability

One of the main aspects of money is ‘salability’. ‘A commodity is more or less - saleable according to the fact that we are able, with more or less prospect of success, to dispose of it at prices corresponding to the general economic situation, at economic prices’ (Menger, 1892: 245). In other words, salability refers to the ease of exchange of a commodity. The less effort a person needs to exchange a good in a market the more saleable that good is.

When taking into consideration to sell a house, if the house immediately needed to be sold, it is strongly possible that one could not probably sell in its fair value. Besides, if the seller wants to sell in a fair value than he should wait for sometime. The example shows us that house might not be one of the examples of a ‘saleable commodity’. To proceed one step further, if we take into consideration to sell a cloth such as a ‘shirt’, the situation will be more severe because as one might expect, its nearly impossible to sell a second hand garment product on its fair value. Hence, the situation is somewhat different in the case of ‘gold’. Since gold is a much more liquid asset, it is much more easier and quicker to sell it in the market without losing so much value. The same logic applies to other investment instruments such as ‘treasury bills and bonds’. Because both the two instruments could be easily

converted to cash immediately without losing so much value, we can regard both the two instruments 'saleable'.

So, at the same time salability is also a reference term not only for commodities but also for money. Since the origin of money is also a commodity meaning that money had originated from different kinds of commodities, salability is also a big criteria for money. So, cash is the most saleable form of money as everyone might expect because it is the most liquid form of a financial asset. In other words, it is the last form in which all other financial assets would like to transform at the end.

Salability is another expression of liquidity. These two terms actually do not differ when it comes to evaluate the degree of exchanging a commodity. Hence, the more salable a commodity or money, the more liquid it is. In the discussions of liquid assets, cash is the first considered one (Simmons, 1947: 310). The reason for that is, it can be easily converted to any other forms of asset without too much effort. So the easier an asset is converted to other forms, the more liquid or salable it is.

One of the main motives for people to use money to exchange goods and services is the 'coincidence of wants' problem. In order to fulfill an exchange, the two parties' needs should be reciprocal. If we think of a person who produces grain but needs fruits in an environment without money, that person should find another party who is willing to exchange fruit in order to get grain. The relative salability of goods can be assessed in terms of how well they address the three facets of the problem of the lack of coincidence of wants: their salability across scales, across space, and across time (Ammous, 2018: 4). Salability across scales measures the rate at which the good can be divided in order to exchange it in smaller amounts. In order to be saleable for a commodity it should be divisible. The second issue of salability is the salability across space. Salability across space shows how much effort is needed in order to move the good from one place to another. As an example, over centuries gold is practically a good example for a salable commodity across space. In order to be a good substitute for cash a commodity should be easily transported.

The last aspect of salability is 'salability' across time. A good's salability across time refers to its ability to hold value into the future, allowing the holder to store wealth in it, which is the second function of money: store of value (Ammous,

2018: 4). Storing value in a healthy way for the long term composes two criteria which are non-corruption and keeping its value. In order to be a good store of value a commodity should not spoil in the long term such as food products. Besides, even if the item does not spoil it should also keep its value in the long term. In today's world, most of the investors refrain from inflationist money which loses some of its value in time and instead they move to the stronger options such as gold.

Hence, a detailed analysis and explanation from Menger (1892) follows;

The time-limits to the saleableness of commodities are mainly conditioned

1. By permanence in the need of them
2. Their durability or their suitability for preservation.
3. The cost of preserving and storing them.
4. The rate of interest.
5. The periodicity of a market for the same.
6. The development of speculation and in particular of time bargains in connection with the same.
7. The restrictions imposed politically and socially on their being transferred from one period of time to another.

So as explained above, salability across different time periods will remain the most important aspect of money. By the term salability across time, especially for today's terminology it has been emphasized that money should not lose its value over time. Indeed, it is very common to see opposite cases up to now as Hayek (2007) declared 'we will sometimes feel that the value of money has remained approximately constant although many prices have changed, and at other times that the value of money has definitely decreased or increased, although the prices of only a few important commodities have changed but all in the same direction. What then do we call, in a world of constantly changing individual prices, a stable value of money?'

1.3.2. Stock To Flow Ratio

Stock to flow ratio is one of the most crucial aspects of salability. The stock, which is a commodities' existing supply, consisting of everything that has been produced in the past, minus everything that has been consumed or destroyed. The

flow is the extra production that will be made in the next time period (Ammous, 2018: 5). The higher its stock to flow ratio, the more salable that the medium of exchange is. The underlying reason for this is that market price of the commodity money does not change due to the low flow ratio.

In a free market economy, the prices of goods are set according to supply and demand. High flow ratio increases the supply of a commodity drastically leading to a loss in its market price. When there is a healthy and stable demand, a shift in the supply side of all goods results in a loss in prices. The similar situation might be true even in economies where there are continuous increasing demand. If stock to flow ratio of a commodity (gold, iron, silver, oil) can easily be altered, then a shift in its demand will push its price up which again finally will move producers to produce more in order to obtain more profit. Taking into consideration an economy where there are countless producers thinking and acting in the same way so as to the stock to flow ratio will suddenly decrease because all the profit oriented producers will produce more leading to a shift in that commodities' supply. The additional supply finally results in a decrease in the price of that commodity (inflation).

The explained process of inflation partially explains United States housing crises in 2008. With the rising idea that 'all Americans should have a house' led bankers distribute mortgages to noncredible investors. These subprime mortgages caused an euphoria of investing on houses leading to rising prices (housing bubbles) and construction in housing sector. The rising prices called a lot of attention from investors and at the same time construction firms. This cycle had also grown by selling risky loans to high risk borrowers by giant and 'credible' financial institutions (Aalbers, 2008: 12). The result was hardly close to the expected optimistic scenario. Soon, individuals started to have hard time paying their mortgages and realized that they might not be able to pay the whole mortgage. After more and more people understood that sad truth, housing prices started to crash and 'housing bubble' burst. There were a big excess supply of houses which will not be demanded in near future. The houses bought during the bull market were again put on sale or sold with a big loss. The remaining houses were all idle (Stiglitz, 2012: 42).

There is also a similar case regarding bank currency. Time to time Central Banks print banknotes in order to finance its debts resulting in inflation. As Mises

(2020) stated, when wealthy and rich nations' parliaments decided to increase government spending they debate different kinds of tax methods and laws for months. They search for the ways to generate income with taxation but at the end they decide to do it with inflation.

Furthermore, in order to finance government spending, sometimes taxation might not be a reasonable choice. Parliaments might have hard time deciding on a new tax law because they might be afraid of voters' reaction in the next election. Hence, they find it much more easier to finance those kind of spending with CB money. Central Bank prints banknotes and finance governments in order to sustain government spending which leads to inflation (Friedman, 1971: 846).

1.3.3. Acceptability

Taking into consideration stock to flow ratio, one of the important aspect of a commodity or currency is 'acceptability'. The more people accept a monetary medium, the more liquid it is, and the more likely it is to be thought and sold without too much loss (Ammous, 2018: 7). Hence the term acceptability is closely linked with 'liquidity'. Acceptability is also linked directly to that medium's reputation, in other words how many people know that medium of exchange.

In today's global economic system, among hundreds of currencies or commodities there are only a few currencies or commodities accepted worldwide. Those currencies are exchanged and traded all over the world with minor losses during trades because of their wide acceptance. Mass accepted medium of exchanges such as United States Dollar (USD), Euro, and gold as a commodity on the other side are also welldone catalizors for the whole world trade. Because they are widely accepted, those medium of exchanges enable traders all over the world to connect in a monetary sense resulting in a flawless trade environment.

Another important issue is that acceptability term directly refers to one of the main aspects of money's 'medium of exchange'. As Wicksell (1906) defined, a medium of exchange is an object which is taken in exchange, not on its own account, not to be consumed by the receiver or to be employed in technical production, but to be exchanged for something else within a longer or shorter period of time. Although David Ricardo (1817) argued that any good which does not have any area of use or

in other words, a good that does not give any satisfaction to its user is deprived of a medium of exchange specifications as Wicksell defined above, the finance medium should not have to have an intrinsic value. Therefore, a medium of exchange could possibly be either commodity or fiat money. A commodity money is an object used as a medium of exchange that also has use areas as a consumption good or a productive input, at least potentially. A fiat money is an object used as a medium of exchange that will never be used as a consumption good or a productive input (Kiyotaki and Wright, 1992: 18). Commodity money derives its value from its intrinsic value whereas fiat money has no intrinsic value.

Because fiat money has no usage area other than payments or in other words it does not fulfill owner's satisfaction other than payments of transactions or it does not have any intrinsic value, it might be argued that it does not have acceptability aspect. However, this kind of a logic will possibly result in failure if it is taken into consideration that all over the world, different nations' citizens accomplish transactions with fiat money without any problem regarding acceptability. The reason behind that is fiat money derives its value or acceptability from governments. In other words, the credibility of fiat money is backed by governments.

1.3.4. Sound Money vs Unsound Money

After a detailed analysis of salability of money with detailed explanation of stock to flow ratio and salability, it would be a better way to proceed with detailed analysis of hard money and go on with Sound Money versus (vs) Unsound Money. As Ammous (2018) stated, money's hardness can be understood through understanding two distinct quantities related to the supply of a good which was explained above: the stock, which is its existing supply, consisting of everything that has been produced in the past, minus everything that has been consumed or destroyed; and the flow, which is the extra production that will be made in the next time period.

In order for a currency to be evaluated as a hard money it should have a high stock to flow ratio. In other words, additional supply in a unit of time should be a minor percentage in proportion to the total supply. If that case is satisfied then the additional supply would not change the total supply easily and the value of that

currency could not be easily altered. Just as the word ‘hard’ calls for the word ‘though’, hard money is indeed though money because its value can not be altered easily.

The easy money on the other hand, is a kind of money that misses those kind of specifications listed above. Supply of easy money could easily be altered generally resulting in loss of value. Besides, easy money might have very low stock to flow ratio in some time intervals meaning that the additional supply during some periods has a very high percentage in proportion to the general stock level. In the environments in which easy money is exchanged, there is an authority or player that controls the whole money supply. Central Banks in modern economies are the best examples for these kind of authorities. Furthermore, in some commodity money environments, because of an invention of a new technology or discovery of a new resource, stock to flow ratio which was stable during decades might suddenly altered and changed resulting in a sudden decline in price of that commodity. Such cases were present during some time intervals in history such as after discovery of the continent America, the precious metals which were found in this new continent were transported with marine ways to Europe ending in loss of value of that metals.

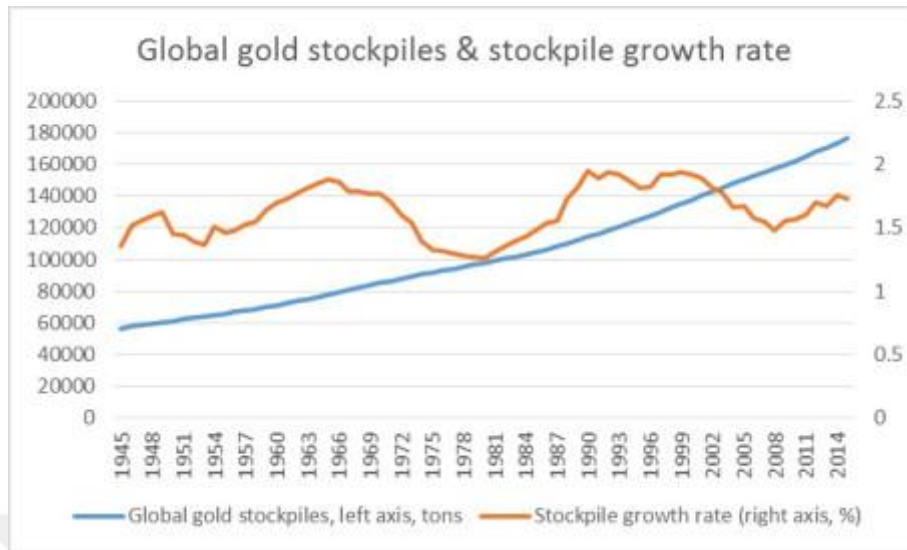
The easy and hard money distinction may also be debated in the light of the two types of money; commodity vs fiat money. Commodity money such as gold derives its value from the substance which it is composed of. Gold’s nominal value or in other words purchasing power is very close to its intrinsic value or material value (Güven and Şahinöz, 2018: 191). Commodity money has an intrinsic value and besides, serves for a purpose of usage such as gold or silver. In other words commodity money is originated and composed of some kind of commodity which has some areas of usage other than payments whereas fiat money generally refers to the paper money printed by the governments’ central banks. In other words, it refers to the money we use today.

Fiat money might be the best example for the term ‘easy money’. The crucial reason for that is its money supply is controlled with an authority such as governments’ CB. In today’s economies, central banks are the only authorities which can alter the money supply in an economy. Governments generally borrow money

from central banks in order to finance some of its expenditures which could not be financed with taxes.

On the other hand, gold which is a suitable example for the term commodity money, might be regarded as hard money. Gold mining implies too much effort and furthermore, mining gold is a costly process. Even in cases where because of excess demand, gold prices rise and when miners are much more motivated to dedicate more resources in order to obtain more gold because of the nature of gold mining, the extra additional supply could not effect total supply and finally there would be no radical change in its final price. As Ammous (2018) suggested, for anything to function as a good store of value, it has to appreciate when people demand it as a store of value, but its producers have to be constrained from inflating the supply significantly enough to bring the price down. Since its supply could not be altered easily, meaning that having high stock to flow ratio, gold value could not be affected by third party actions at least in short term. During the last century, gold stockpile growth in other words, relative changes in proportion to the existing stocks of gold was roughly between % 1,5 and % 2(Figure 5).

Figure 5: Global Gold Stockpiles & Stockpile Growth Rate



Source: U.S. Geological Survey

Sound money on the other hand, is another form of hard money. Just like the term hard money, sound money is that its supply can not be easily altered by the third parties. Besides, sound money - like hard money – has a very stable and high stock to flow ratio. Extra additional supply per a time interval does not effect directly to its whole supply, so sound money do not face with radical price declines because of a rapid increase in output. As it is explained above, during centuries, gold might be a perfect example for sound money since it has a very high stock to flow ratio and it does not encounter radical price declines because of a supply shock.

The additional benefits of sound money in the lights of above information is that it is a healthy store of value. The reason for that is, supply of sound money can not easily altered and the additional supply per a period is a small percentage in proportion to the whole supply, so the investors might be sure that in the long time interval it has a low probability to lose its value. Yet, during the time of increasing demand periods, sound money has a high probability to appreciate in value in the long term.

Unsound money on the other hand, is a type of a medium of exchange which's supply could be easily altered resulting in a loss of value in the long term. The most suitable example for unsound money is government fiat money. With the engagement of central banks, fiat money supply is controlled by central banks in

other words governments. Whenever governments have some financial hard time, and if they can not finance this situation with taxes – generally they can not because of voters negative reaction to taxes- they search for alternative options such as printing money. Since in general sense, fiat money which is a type of unsound money that could be easily printed, its supply might change radically leading to inflation and loss of value. So unsound money tends to depreciate in value whereas sound money appreciates in value in long term.



CHAPTER TWO

BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND BITCOIN

2.1. GENERAL OVERVIEW

After the global crises in 2008 which was originated from the subprime mortgage crises in United States (US), FED applied the quantitative easing monetary policy. As quantitative easing policy involves, the money supply was expanded in a huge scale in order to cope with recession and stimulate aggregate demand. In a few years time, the monetary authorities were able to settle the economy down but during that period, the investors and economists faced with the situation how central banks can interfere the economy, increase and inflate money supply which are the actions leading to a decrease in the value of national currency. Just in that period, an anonymous person, people or firm named Satoshi Nakamoto (2008) whose identity was even not discovered today created a a peer-to-peer version of electronic cash called Bitcoin allowing onlinepayments to be sent directly from one party to another without a financial intermediary. In another way, it was the proposition and creation of a virtual money, a different form of digital money which is completely free from financial authorities and in order to send and receive this form of monetary instrument one does not need banks. This type of wealth transmitting mechanism is a peer to peer mechanism. In another words, the sender and receiver of transaction does not need to get consent from any other party in order to execute transactions.

The technology behind this new invention of virtual money is called Blockchain which will be debated in the next section in detail. Hence, as a short introduction, blockchain technology is based on a distributed ledger technology where transactions are recorded on blockchain. Ledgers in this blockchain technology is just like random ledgers which are kept in accounting process. To explain briefly, ledgers are the main instruments of record keeping items of accounting process. Ledger records show transactions between accounts. In addition to this, they reveal an account's balance in that time. Moreover, they show which account owes what to the other account. Besides, ledgers which transactions are recorded are kept by all nodes in the ecosystem rather than in several servers. The important difference of cryptocurrencies or virtual money lies behind this distinction.

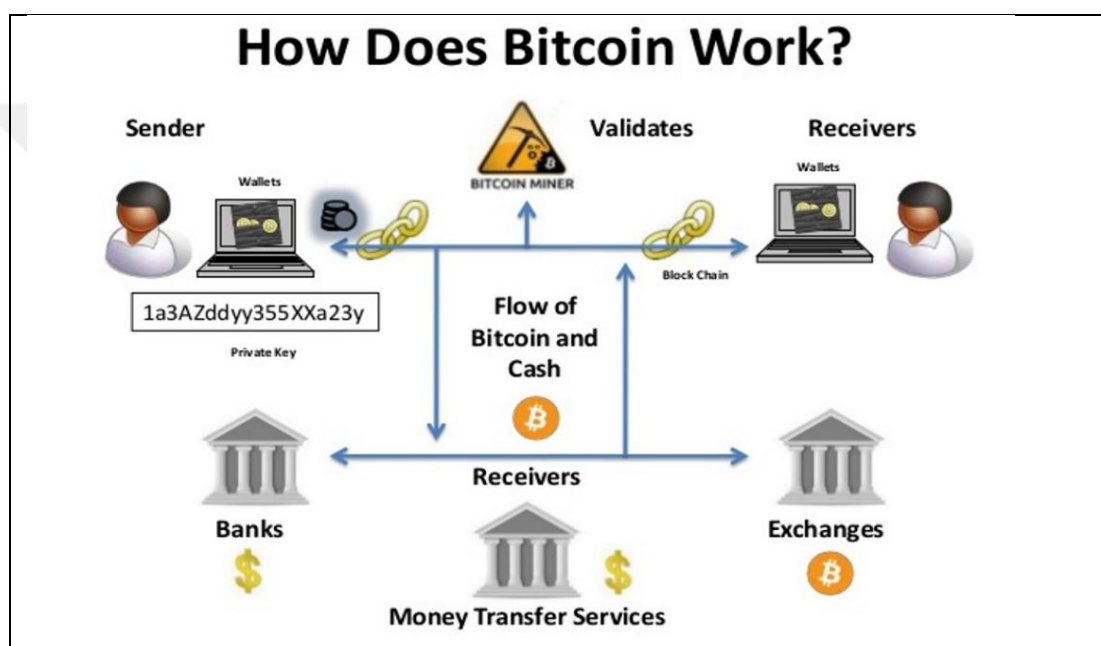
In the finance world up to now before this technology, all monetary transactions' ledgers have been kept in several servers of banks as an intermediary institutions whereas in blockchain's distributed ledger technology just a simple computer with an adequate internet connection which is called 'node' in blockchain ecosystem can serve as a microserver. So there are countless of nodes all over the world supporting this ecosystem as distributed ledgers.

2.2. BLOCKCHAIN TECHNOLOGY

After a brief introduction of that newly invented blockchain technology, it is better to deeply analyse what blockchain technology is. The blockchain is a chain of records of transactions, and miners add to the blockchain by solving a computational problem and adding new transactions(Dwyer, 2014: 5). Those transactions might be sending and receiving of cryptocurrencies, ownership of estates or record of international logistics. Blockchain is not only suitable for cryptocurrencies but also suitable for recording real estate transactions and/or logistic databases. In other words, despite the general tendency and confusion that blockchain database is only used for cryptocurrencies, it might also be a great option for recording other applications and instruments. Another entities, miners are the distributed nodes who compete for solving complex mathematical formulas which is called proof of work. In a proof of work system, miners compete with each other in order to solve a complex problem. In order to solve such problems, miners have advanced computer hardware. Because of solving such complicated problems is a hard work, this process is called 'proof of work'. Proof of work system is a system that shows that miners have accomplished a hard task when they have solved the complicated computational problem. Actually solving the computational problem is not an easy task. Indeed, it is a hard and challenging task to solve that complex mathematical formulas which are called hash functions. A hash function is a transformation of the original information (Dwyer, 2014: 83). The original information is coded as a hash function on the blockchain. Furthermore, miners should have superfast computer hardwares in order to solve such formulas. Within the process of mining, miners are entities which approve whether a transaction is valid or not. Furthermore, miners are the ones who hold the blockchain ecosystem alive. In such a system, miners also care for the

security of the system. In other words, miners are the guardians of the system like police officers or soldiers in real world. Figure 6 demonstrates how Bitcoin blockchain system works basically. When someone sends bitcoin to the other party, miners approve the transaction. In exchange for this approving mechanism miners get a reward of Bitcoins. This reward is newly created Bitcoins added in Bitcoin money supply. Besides, miners also get commissions which are cut from the exchanged amount.

Figure 6: How does Bitcoin work?



Source: digitalflip.co

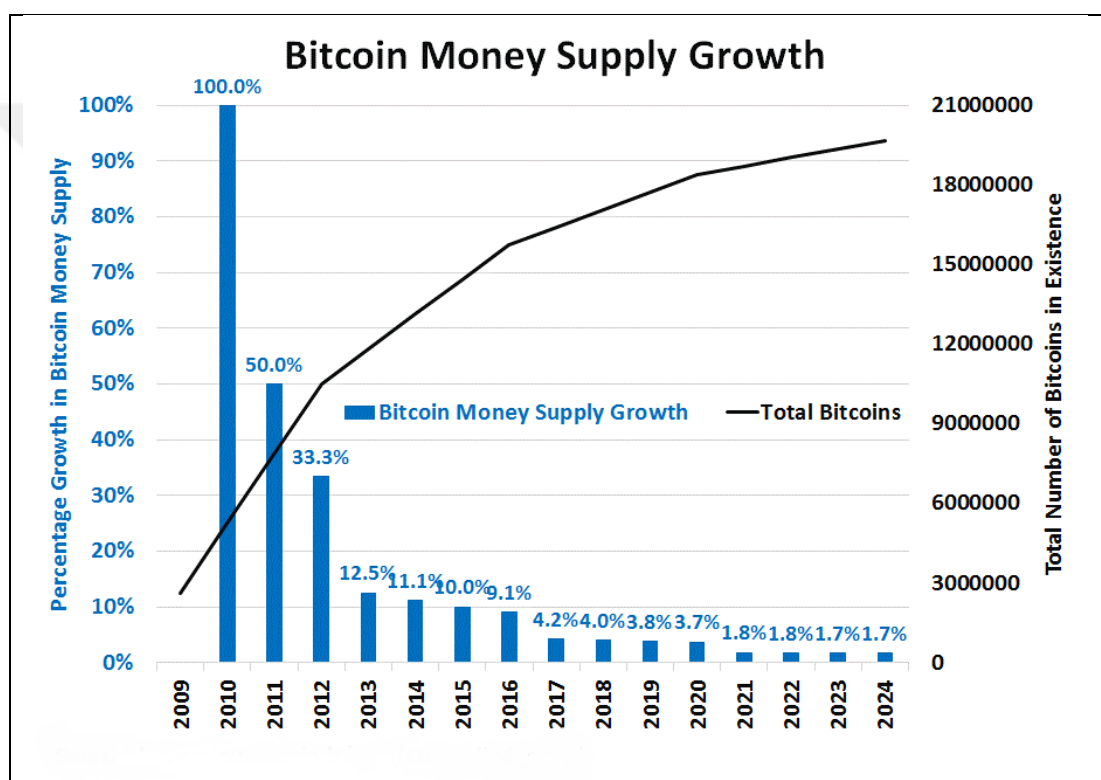
As indicated before, there is a tough competition in between miners in order to solve complicated hash functions. The first miner who is able to succeed is rewarded by fresh minted bitcoins. That process is called mining process. Mining process in blockchain is just like money printing process by central banks in today's world. So, miners act like central banks in blockchain ecosystem. The crucial difference here is that, in real world central banks are the only authorities whereas in blockchain system there is no central authority and nodes which are called miners are located everywhere. Besides, in addition to fresh minted coins, miners also get commission fees which is a small part of amount transacted. In order to increase the probability to solve hash functions miners need to have advanced computer

hardwares. Miners' primary focus is to earn newly formed Bitcoins. These Bitcoins are offered as a reward for the miner who approve the block including transactions. But there are a lot of miners who are dedicated to approve transactions and form blocks. In order to choose the approving miners, the system offers a complicated computational problem. Miners who solve the problem first form a block in blockchain and get the newly minted Bitcoins as a reward. And the new block is added in blockchain. This is how Bitcoin transactions are approved. Those parties also use special external hardwares such as Asic miners and they might also form mining pools by uniting their dedicated powers in order to increase their chances of success. Approximately, in every 10 minutes a 1 Megabyte (MB) block is formed and added to blockchain with the mining process. These formed blocks are kept as a chain near each other. That's why the system is called blockchain. With each block produced, the succeeding miner is rewarded with 6,25 bitcoins. Furthermore, the complexity and difficulty of hash function algorithm depends on the total dedicated mining power which is called hash power that miners have in order to mine Bitcoins. Hash power is a demonstration of how powerful a miner is. The algorithm adjusts the difficulty in a sense that in every 10 minutes one block should be formed. If few miners are interested in mining process the total hash power decreases and the algorithm also decreases the complexity in order to stabilize each new block time to 10 minutes. However, when there is an increased popularity among miners and increased total mining power, then the system adjusts by increasing the difficulty. So basically, the blockchain algorithm automatically adjusts its complexity depending on miners' total hash power. After every 210,000 block, roughly in every 4 years, the block reward is halved. The next halving will be in the year 2024 after forming 210,000 block and the halving reward will be 3,125 Btc.

The money supply of Bitcoin is also programmed before with the rules of the mining algorithm. With each block formed, the 6,25 Btc reward is added to bitcoin money supply and is given to miners as a reward. As mentioned before, this is the money creating process of the blockchain. So, the Bitcoin supply algorithm is known even from the creation of bitcoin and it is not changeable. The important difference of blockchain's money creating process from today's finance world is that in the latter, central banks are able to create as much money as they can whereas in

blockchain system money creating is limited and defined by the rules of the algorithm just at the beginning. Figure 7 shows the bitcoin supply growth on a yearly basis. The percentage growth is decreasing every year till 2140, the year when the last Bitcoin will be mined. The total maximum amount of Bitcoins can only be 21,000,000. After 21,000,000 Bitcoin is mined in the year 2140, the total supply of Bitcoins will be fixed. Indeed, there will be no more Bitcoin to mine because of the preprogrammed fixed Bitcoin algorithm.

Figure 7: Bitcoin Money Supply Growth

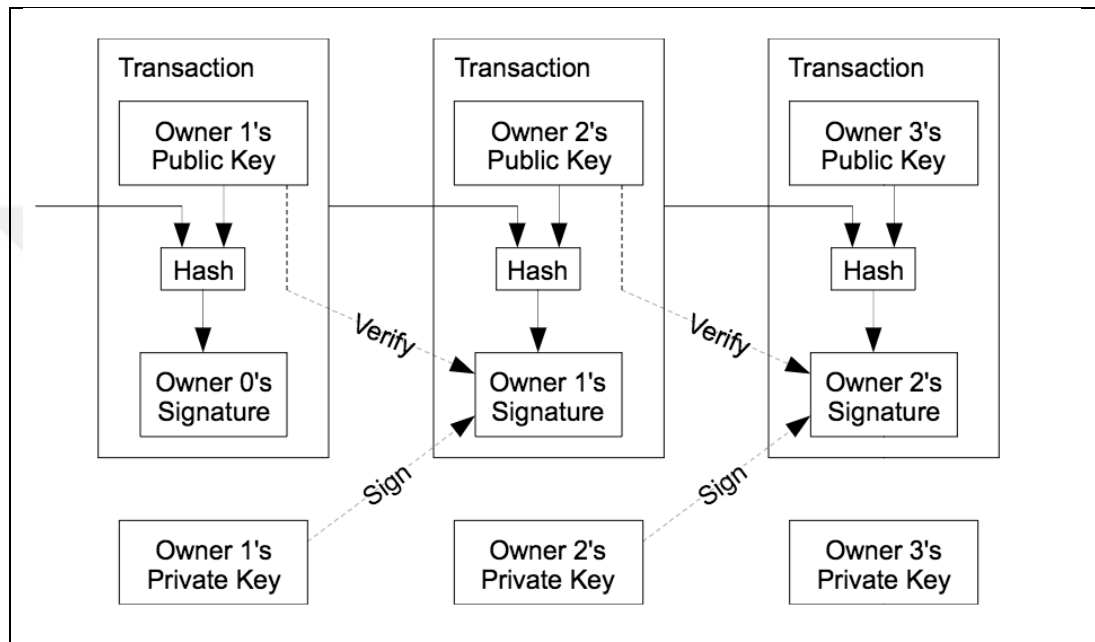


Source: CME Group (<https://openmarkets.cmegroup.com/12749/bitcoin-gold-growth-comparison/bitcoin-money-supply-growth>)

Blockchain has no central server or verification mechanism. Instead, blockchain and Bitcoin have thousands of decentralized nodes all over the world approving transactions in the system without the need of trust. As explained before, the information in blockchain is coded as a hash function. Hash functions are actually SHA 256 algorithms and a hash takes a part of data as input and shrinks it down into a smaller hash value (Ankalkoti and Santhosh, 2017: 1758). In other words, hash functions are zipped versions of data in blockchain. As Figure 8

indicates, in order to transfer Bitcoins from a user to the other on blockchain each owner transfer the coin to thenext by digitally signing a hash of the previous transaction and the public key of the next ownerand adding these to the end of the coin. A payee can verify the signatures to verify the chain of ownership(Nakamoto, 2008: 2).

Figure 8: Cryptographic Transmission

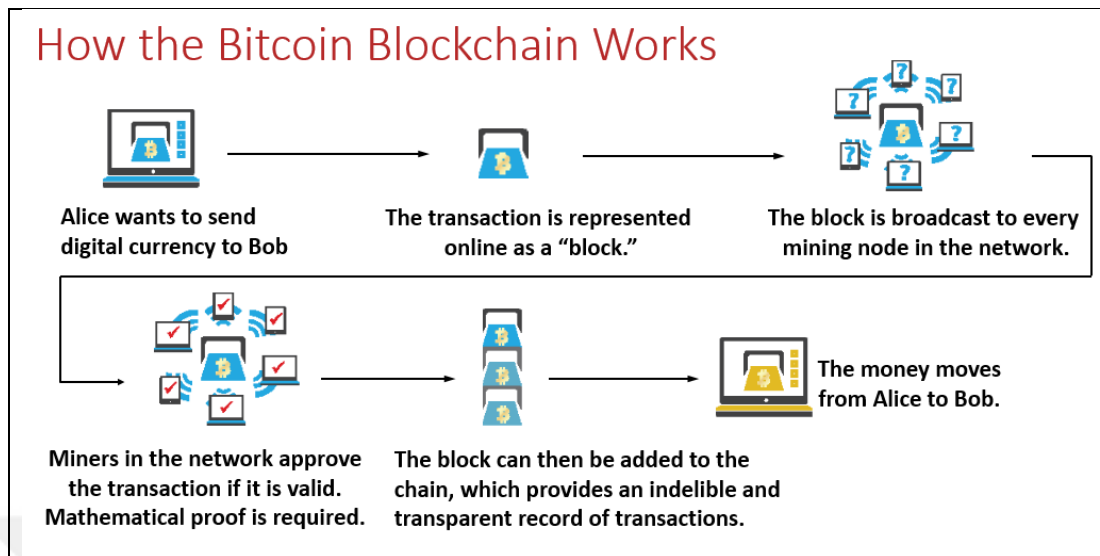


Source: Nakamoto (2008:2).

The mechanism continues step by step. In the next step, after Owner 1 received coins and when he wants to send them to Owner 2, this time he signs the hash of the transaction 1 with his private key and Owner 2's public key and sends the amount to Owner 2. Indeed, for simplicity one might think that private key is like a signature and public key is the receiver address. Besides, hash function is the cryptographic form of the transmitted information. Private key is a very important issue since it enables a user to accomplish a money transfer transaction. Without private key such process is impossible. Private keys are like the passwords of our bank accounts. Anyone, who has the private key of an account has all the control of Bitcoins. Public keys on the other hand, are the addresses of receivers. They are revealed and visible on blockchain. Anyone can see each other's public key and this does not pose a threat.

A payee can verify signatures to verify the chain of ownership. However, the payee is not able to verify whether owners did not double-spend the coin. Double spending is the act of spending Bitcoins more than once. In other words, after sending Bitcoins, before the transaction is validated sending same coins to the other party again. After sending Bitcoins to another party, generally it takes 10 to 30 minutes for the transaction to be approved. In this process, the sender is able to send same Bitcoins to another party called double spending. This is like spending or sending the same money in your bank account twice. Double spending problem is the hardest issue to solve in virtual monetary system. Blockchain's most important aspect, its core competence is solving the double spending problem. After solving double spending problem, then blockchain system became suitable for a healthy wealth transmission mechanism. So, in order to avoid double spending problem when a party wants to send some coins to others as Figure 9 shows, the transaction is represented as a block and the block is broadcasted to every mining node in the network. Then, miners approve the transaction if it is valid by proof of work. Miners, who are like guardians of the system approve that the payer did not spend or sent the same amount twice. That is a very crucial process for the security of blockchain system. In today's financial world, banks are responsible for controlling depositors' accounts. For example, when someone transfer money to others, banks credit sender's account and debit the receiver's. But in blockchain system, this process is completely done by miners. Miners approve data into blocks containing information about who owns how much Bitcoin and who sent how much Bitcoin to another. So apart from acting like central banks in money creation process, miners also work like commercial banks. Afterwards, the block is added to the chain providing record of transactions called blockchain.

Figure 9: How Blockchain Works



Source: Accountex Network Accounting Technology Experts

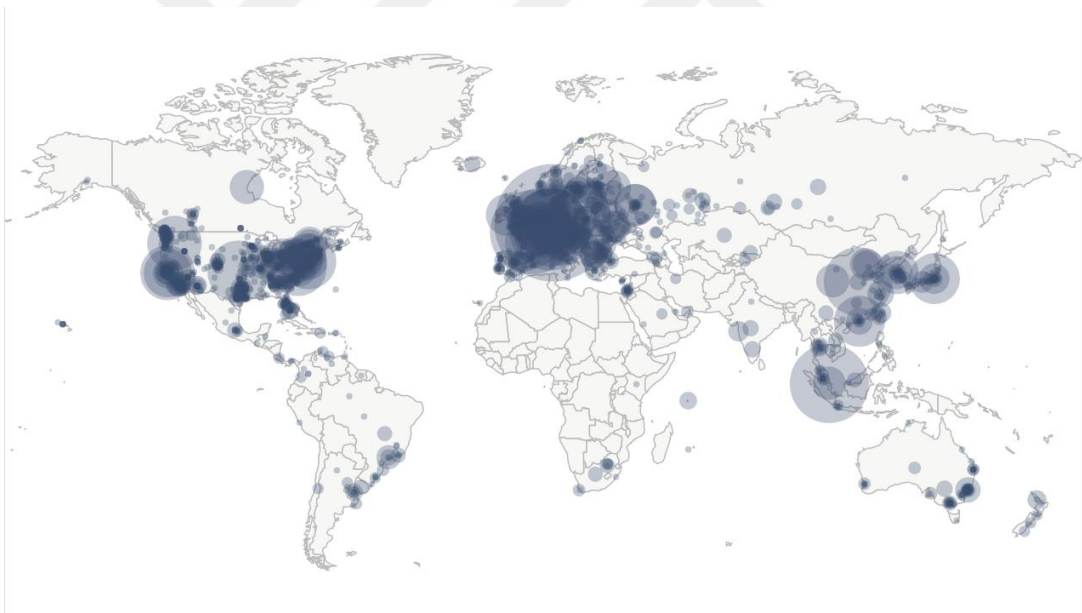
All recorded transactions are kept like a ledger in each nodes' records. As said before, nodes are like small servers keeping blockchain ledgers all over the world in blockchain system. If one or some of the nodes happen to be damaged, corrupted or lost, the system keeps operating without any problem due to the decentralized form of blockchain. If one or more nodes are lost in the system, the other nodes serve as microservers for keeping ledgers. Besides, it is also impossible, at least within today's technology, to shut down blockchain in order to prevent it from working. In order to ban or shut down blockchain one should reach each node and paralyse all of them. In other words, in order to ban blockchain one should place a guard in front of each computer serving for a node in the system. Figure 10 below shows the reachable 9681 global bitcoin nodes located all over the world at the time of 20:54:22 GMT +03 on 08.04.2019. As explained, above nodes which serve for recordkeeping ledgers are located in very different regions in the world.

Blockchain technology has great importance in Financial Technology which is called Fintech. One of the main advantage of blockchain technology is that it has nearly instant settlements whereas banks might need nearly a week to settle account operations. So blockchain technology offers a fast and efficient way for settling down process. Moreover, this quicker settlement option eliminates the need for many back office staff and operations since settlements are done in minutes.

Blockchain technology is also suitable for smart contract operations. With the help of easy settlement operations, contracts can be executed automatically when two parties obligations are met. This innovation also eliminates costly and time consuming operational processes for banks. On the other hand, blockchain technology might help banks to increase transparency. Since account and account's transaction history are all visible in Blockchain there would be no problems about transparency. That option also plays an important role for decreasing cases of fraud.

This new technology is also crucial for cross border micro payments. With the help of blockchain technology, micro and medium sized cross border payments are executed in minutes. So blockchain technology decreases transaction time and operational costs. Besides, users do not have to pay for high commissions for these cross border payments.

Figure 10: Reachable Global Bitcoin Nodes



Source: <https://bitnodes.earn.com/>

2.3. BITCOIN

Bitcoin is the first and the most popular cryptocurrency in the World. Even after more than 10 years from its first proposal, it is still exchanged all over the World. Besides, despite the debate that it is a big bubble and will be worthless sooner and later, it is also still used. In this section, Bitcoin will be explained and analysed

in detail. Furthermore, definition of Bitcoin, Bitcoin ecosystem, actors in Bitcoin ecosystem such as miners, e-wallets, exchanges and aspects of Bitcoin such as financial freedom, limited Money supply, peer to peer transactions, distributed ledger technology, pseudonymity, divisibility, security, fast, inexpensive, 7/24 wealth transfer will be elaborated.

2.3.1. Definition Of Bitcoin

Bitcoin is the first and most valuable cryptocurrency equivalent to approximately 5219 USD and has a market cap of 92.039.398.672 USD according to coinmarketcap data at the time of 21:36:32 GMT +03 on 08.04.2019(www.coinmarketcap.com). After its creation in 2008 by the anonymous character Satoshi Nakamoto and first transaction in 2009, it has made great impact around the finance world especially among those who are against government and central bank intervention to the economy. Besides, also with the impact of social media and its spillover effect, the newly invented coin became popular and its price has risen from 0,04 USD (17.07.2010) to 20748 (17.12.2017)(<http://www.bitcoinity.org/>).

Being a recently invented technology and a new asset class, Bitcoin has attracted great attention from people in finance and also other investors. Because of its decentralized nature and limited supply, it has attracted investors' attention. Besides, Bitcoin also resembles to gold because it is not in a monopoly of any nation such as dollar and euro. In other words, Bitcoin is nationless. In addition to this, no country has the monopoly to print or issue Bitcoin by its central banks. In this sense Bitcoin ecosystem is also free from central bank intervention. Central banks are neither able to print Bitcoins nor they have the right to regulate its money supply. Actually, any authority can not regulate bitcoin money supply because mining rules and bonus Bitcoins which are given to miners as a reward for verification of transactions are set up in the algorithm from the beginning. Even miners can not interfere money supply process. Because of the fact that there is no hidden state powers such as central banks or regulatory authorities manipulating, and because everyone can also print his own Bitcoin – at least theoretically – the Bitcoin system is some sort of democratization of monetary world. Moreover, as explained above,

there are no intermediaries in Bitcoin ecosystem such as banks in the modern finance world. To give an example in today's finance world, when someone sends funds to the other party there should be an institution setting a trust mechanism between the parties of transaction. A party like a bank should monitor whether sender has enough funds to complete the transaction and this party should be trustable. With the verification process of Bitcoin, by the help of miners and Bitcoin nodes, the bitcoin ecosystem has eliminated the need for trustable mechanism such as banks. Instead, the whole system works by a verification process which was attacked countless times but not hacked even 10 years after the system started. Today, despite all digital and manipulative attacks, after 10 years this nationless money is still traded and exchanged all over the world without the need of banks at the price of 5219 USD at the time of writing.

However, Bitcoin has also some disadvantages such as double spending problem. Double spending problem is the risk of sending the same fund twice before the transaction is approved. This situation might be the most crucial issue in the cryptocurrency ecosystem. Because, normally in routine finance operations, it is bank's duty to check whether a sender has enough fund to send and complete the transaction but in blockchain ecosystems such as Bitcoin, miners are in charge of that operations. In such a verification process, it generally takes 10-30 minutes for a transaction to be verified. In this time period, a malicious user might attempt to send funds for a second or third time before the first transaction is approved. In this situation, there appears another chain of blocks rather than the original honest chain. Regarding that other miners are honest, the original chain's blocks are approved and it grows longer and the system accepts the longer chain so the first transaction is approved and the second and third fake transactions are not taken into account.

Normally, it is practically impossible to exploit double spending and take advantage of that action. As explained above, in case of such an attack, honest nodes will not approve the fake blocks and honest blocks will form the longest chain. However, if more than 50% of miners are not honest, the situation changes. In such a case, dishonest nodes might all approve the fake transaction and the chain including fake transaction will be the original chain. In this situation Bitcoin system will collapse suddenly dragging Bitcoin's value to zero in a very short period of time. But

actually, this act is a war with no winners. Because the value of Bitcoin will be near zero suddenly, the dishonest nodes trying to take advantage of this exploitation will be left profitless and taking the majority of the system requires too much resources and energy that it does make no sense. Up to now there have been no successful double spending attacks on any Bitcoin transactions that have been confirmed at least once (Ammous, 2018: 243).

2.3.2. Bitcoin Ecosystem

Bitcoin ecosystem is the environment where Bitcoin, actors and items related with Bitcoin come together. Miners, e-wallets and exchanges are major elements of Bitcoin ecosystem. Miners are entities approving transactions in exchange for bonuses and transaction commissions. They can also be called 'guardians of the system' because they protect the solidarity of Bitcoin blockchain. On the other hand, e-wallets can be called personal banks in the system. They are softwares where users can deposit their Bitcoin. So in this context, actually they act just like personal banks. Moreover, exchanges are platforms where investors can exchange Bitcoin for USD or other main cryptocurrencies or vice versa. Because of the rising interest in the last years, the number and volume of exchanges has recently increased considerably.

2.3.2.1. Miners

As defined before, miners are units who approve transactions by solving complex mathematical formulas. So, miners are bodies who are in charge of the Bitcoin ecosystem's security. Besides, miners are also in charge of increasing the Bitcoin supply according to a predesigned algorithm by collecting rewards arising from approved transactions. Furthermore, miners also benefit by collecting transaction commissions. In order to sustain the system's design, transaction commissions are cut from sender in a proportionate amount and distributed to miners. So miners have two different cashflow such as transaction commissions and bonuses as rewards of approving mechanism.

Due to complex mathematical formulas which must be solved by miners in order to contribute to approval process, miners should have high resources and advanced infrastructure such as the latest technology of graphic cards and cpu

powers. As bitcoin ecosystem grows, matures and becomes widely known, the system's hashpower, namely total power of miners' equipment increases. Besides, because of the depreciating value of Bitcoin in the year 2018, mining operations are getting less and less profitable. Recently created Bitcoins constitute a high percentage of miners' revenue. So, as Bitcoin's value depreciates, miners' revenue also decreases. Mining Bitcoins is a hard and costly operation which requires too much electricity usage. Because the hash power is increasing in the long run, minting each Bitcoin becomes more costly each day. Table 1 suggests the mining costs of 1 Bitcoin by using different special design mining infrastructure in different countries as of 22.02.2019 (Phillips, 2019: 1). So in order to survive and cope with such kind of financial problem like every profit oriented firm, miners also search ways for staying profitable. The most intelligent solution in such a situation would be combining hash powers of more than one mining firms such as forming mining pools and taking advantage of economies of scale. At the end of the process, today the surviving mining companies are generally ones who take advantage of economies of scale and reducing their costs.

Table 1: Mining Cost of 1 Bitcoin

Mining Hardware	Electricity Costs Involved in Mining One Bitcoin (USD)					
	Venezuela	India	Spain	U.K.	U.S.	Canada
Ebang Ebit E11++	249.76	1998.08	5994.24	5494.72	3246.88	2747.36
ASICminer 8 Nano	249.76	1998.08	5994.24	5494.72	3246.88	2747.36
ASICminer 8 Nano Pro	290.66	2325.28	6975.84	6394.52	3778.58	3197.26
Innosilicon T3 43T	270.42	2163.36	6490.08	5949.24	3515.46	2974.62
Antminer S15-28TH/s	317.37	2538.96	7616.88	6982.14	4125.81	3491.07

Source: www.beincrypto.com

2.3.2.2. E Wallets

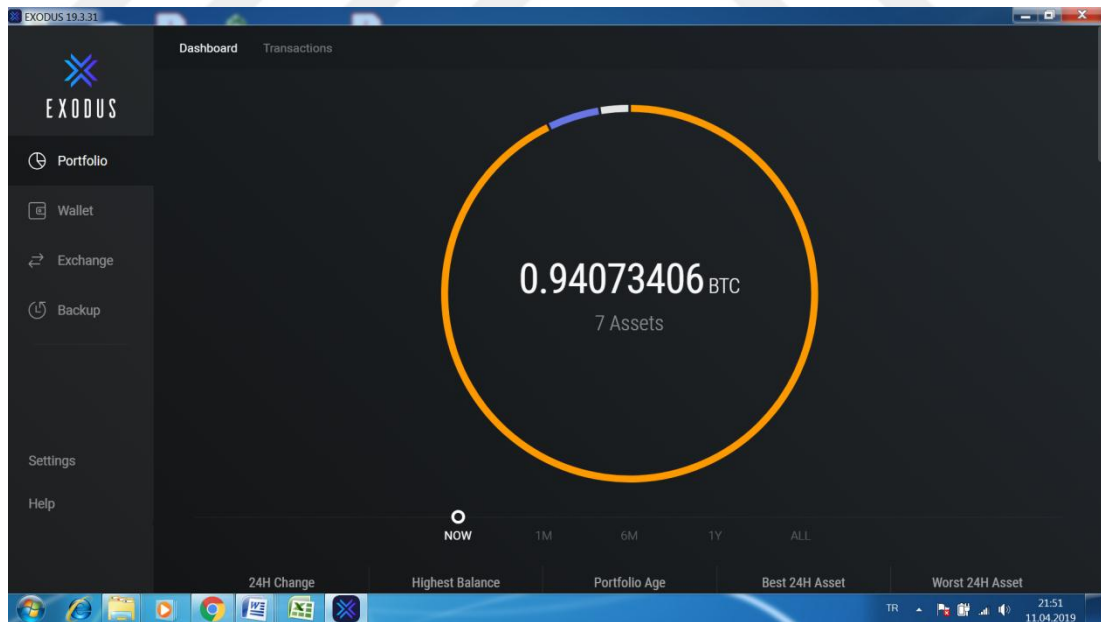
E wallets are types of software allowing the user to reach his private key in order to access his account. E wallets, in general sense seem like electronic wallets enabling the investor to store his funds as cryptocurrencies. In this sense, they are like one's own bank accounts. Actually and technically, funds are not stored in e

wallets, indeed an e wallet enables its user to reach his private key which works as a signature or a key to lock in his account. So e wallet does not store funds, rather it stores one's private key or digital signature that lets him to access his funds. But rather than a deep technical explanation, it might be regarded in general sense that e wallets are like digital wallets of cryptocurrencies.

Because the system is decentralized and free from any central authority, by using e wallets one can have his own individual bank in his computer. Basicly speaking, with a basic e wallet and enough Bitcoin and a moderate internet connection an individual can send money to anywhere in any time without getting any permission or consent from any financial institution. Thus, this ease of use and freedom might be a game changer development in financial world in near future.

There are different wallets such as hardware, desktop, mobile, and paper (Gültekin and Bulut, 2016: 87).Desktop wallets are the ones operating on computers such as Exodus, Electrum, zapo etc. Figure 12 shows the dashboard visualisation of one of the most popular desktop wallet, Exodus.

Figure 11: Exodus Dashboard



Source: An Anonymous Personal Computer

Mobile wallets can be used in mobile phones. Abra and Coinomi are the two most popular mobile wallets. Hardware wallets are hardwares like a flash disk which

has a software inside to store funds such as Ledger Nano S and Trezor. Figure 13 shows a demonstration of the most popular hardware wallet, Ledger Nano.

Figure 12: Ledger Nano Hardware Wallet



Source: www.coinrevolution.com

Paper wallets are one of the safest but also simplest ways of storing Bitcoins and cryptocurrencies. The method is nothing but keeping the private key of funds on a paper. By doing this, private keys which are crucial for accessing funds are kept away from the digital world such as computer, internet and becomes hackerproof. Because private keys are no longer kept in digital machines and software, the Bitcoin account becomes unreachable by hackers. However, this method has also disadvantages because the private key is kept in physical world so by the time it is lost one can no longer reach his funds.

2.3.2.3. Exchanges

Exchanges in cryptocurrency world are platforms where investors buy and sell cryptocurrencies, so technically exchanges are just like traditional exchanges. This trading mechanism is available in both cryptocurrency to cryptocurrency and cryptocurrency to fiat pairs. In other words, traders can exchange Bitcoin with other cryptocurrencies or Bitcoin with fiat currency. Except from Bitcoin, Ether, Ripple,

Dash, Monero and a few other cryptocurrencies, generally most cryptocurrencies are not available to trade directly with fiat money. One cannot directly exchange fiat money with most of the cryptocurrencies. To do that, he needs to first purchase Bitcoin with fiat and use that Bitcoin to obtain the other cryptocurrencies. With rapid improvement and progress in cryptocurrency world, lots of exchanges have been established all over the world. Today as of 13.04.2019, there are more than 200 exchanges operating all over the world with 2170 cryptocurrencies trading and total volume of 42,626,025,300 USD (www.coinmarketcap.com). Table 2 shows top 5 cryptocurrency exchanges according to their adjusted (volume from spot markets excluding markets with no fees and transaction mining) trading volumes. Today, virtual exchanges have minor trading volumes in proportion to the traditional well known old exchanges. However, taking into consideration the potential of this new technology and the world wide interest, these newborn exchanges could grow in huge scales in near future.

Table 2: Top 5 Cryptocurrency Exchanges

Ranking	Exchange Name	Daily Adjusted Volume (USD)
1	DigiFinex	1.202.264.400
2	OKEx	1.110.167.877
3	OEX	1.030.925.232
4	HitBTC	920.310.728
5	CoinBene	875.543.951

Source: www.coinmarketcap.com

Exchanges also serve their customers as a storage of funds. Beside trading cryptocurrencies, investors may also store their crypto funds in their exchange accounts. For this storage mechanism exchanges have e wallets with gigantic amount of funds in them. However, storing crypto funds in exchanges might sometimes be problematic. Hence, it might not be the best option to store wealth in exchanges rather than trading. Especially taking into consideration that every personal computer could easily be turned to personal banks with just a simple e wallet software, it is not a wise way to store wealth in third parties' storage because cryptocurrency exchanges are number one targets for hackers because of the enormous funds of

investors stored on their wallets. During the ten year period in cryptocurrency sector, dramatic examples have been encountered about hacking and theft of cryptofunds. Early Mt Gox Exchange hacking is one of the most dramatic example so far. In the year 2014, Mt Gox was the largest bitcoin exchange operating in Japan. However, the exchange went bankrupt just in February of the same year because of hackers attack. The Exchange lost 767000 bitcoins which 200000 have been recovered but the remaining 650000 which is equivalently 3.309.150.000 Dollars at the time of writing have not(Norry, 2018: 3).

2.3.3. Aspects of Bitcoin

In this section aspects of Bitcoin such as financial freedom, limited money supply, peer to peer transactions and distributed ledger technology, pseudonymity, divisibility, security, fast and inexpensive 7/24 wealth transfer will be elaborated in detail. First of all, financial freedom refers to the notion that there are no financial intermediaries approving transactions. Because of the peer to peer structure of the blockchain system, users can send and receive Bitcoins directly. Moreover, there are no central banks regulating the Bitcoin supply since it has been coded previously in the algorithm. Besides, Bitcoin has a limited money supply and the maximum amount of Bitcoin could be 21000000 at most. In addition to this, in Bitcoin ecosystem transactions are peer to peer and Bitcoin blockchain has a distributed ledger structure, nodes all over the World keep track of transactions maintaining the solidarity and security of the system.

Another issue, pseudonymity means that accounts owners' personality is not visible. But on the other hand, accounts information such as wealth information and transactions are visible to all users in the system. Bitcoin also has a divisibility aspect that it can be divided into 100000000 minor units called Satoshis. So, even its value increases drastically in future there will be so small valued units which make Bitcoin practical in exchanging with other instruments.

Because of the decentralized nature of Bitcoin blockchain system, countless nodes located all over the World serves for great protection making the system immune to third party attacks. After more than 10 years, Bitcoin blockchain system is still stable and operating securely. Moreover, wealth transfer is fast and

inexpensive in proportion to the other wealth transmitting mechanisms such as SWIFT. A Bitcoin transaction could be settled in less than 30 minutes with minor costs. Besides, this transaction can be executed 7 days and 24 hours a week between users located in different regions of the World.

2.3.3.1. Financial Freedom

As mentioned above, Bitcoin system has no central authority. There is no institution regulating Bitcoin's total supply. Besides, there is also no central institution responsible for mining new coins such as central banks. Instead, Bitcoin's monetary policy is stable and arranged just from the beginning of the Bitcoin algorithm. It can not be changed with the decision of an institution or a group.

Bitcoin's supply is increased by miners. As explained before, Bitcoin supply is increased by giving new Bitcoins as a reward to miners for the job they have accomplished in the approving process called mining. Besides, there is no institution working as a trust mechanism like a bank in Bitcoin ecosystem. The system has a decentralized nature and transactions are peer to peer with no intermediary inbetween. In addition to this, after Satoshi's invention of Bitcoin, individuals have the chance to hold their financial freedom. As an example, when they want to transfer funds to another party they don't need an intermediary. Besides, they don't need any institution's consent. The transactions are executed peer to peer all over the world in any time of the day. In order to transfer fiat money to another country one should do it in office hours because banks must be operating. Even the transfer is held in office hours, in an international wire transfer such as Swift, it takes 2 or 3 days to accomplish the transaction. In a Bitcoin system the same transfer could be accomplished in 10 minutes with a reasonable cost. Furthermore, there is no time constraints to transfer these funds. The system is open 7 days and 24 hours. In Swift system, when someone wants to transfer dollars to another country, the amount of transfer is really an important issue since it is tracked by American authorities. As an example, if someone tries to send 10 million USD to another country there will be an authority asking for the details in order to give permission. However, amount of transfer is not important in Bitcoin ecosystem since it all 1's or 0's in computer language. It does not differ technically if someone sends 1 USD or a billion. Besides,

one might send as much Bitcoin as he likes and no one will ask for explanation in order to give consent.

Another issue which gives financial freedom to Bitcoin users is that its supply could not be regulated. Since the first genesis block, Bitcoin supply plan was coded in its algorithm and in each time period the total supply of Bitcoins was decided before. Minting additional coins and inflating Bitcoin supply is impossible as most central banks do today with fiat money. So this fact enables Bitcoin to preserve its value and be a real candidate for sound money.

2.3.3.2. Limited Money Supply

Another aspect of Bitcoin is that unlike fiat Money, Bitcoin's maximum total supply is limited to 21000000 Bitcoins. Any institution even miners in Bitcoin community are not able to increase its supply more than 21000000. This maximum amount of Bitcoin is decided and coded in the algorithm by the time Bitcoin has been created. So, Bitcoin is a good example of hard and sound money because its supply can not be increased after a specific limit.

As mentioned above, Bitcoin total supply is increased by rewards which are given to miners for approving transactions. However, reward process is also regulated according to an algorithm. As an example, at the time when Bitcoin was first created and started to be traded, block reward was 50 Bitcoins. Nearly in every 10 minutes 1 block is completed and 50 bitcoins were given as a reward to the miner who has solved the mathematical formula and completed the block. But also in the algorithm there is a rule that every 4 year Bitcoin reward halves. In other words, in the year 2012, mining reward became 25 bitcoins. After the year 2016, Bitcoin block reward became 12,5 bitcoins and today 6,25 bitcoins are distributed as a block reward. This system continues like that until 21000000 Bitcoin is created. The forecasted time for this limit is approximately the year 2140. The next halving year is 2024 and after that time, the block reward will be 3,125. So as one might guess, Bitcoin has an increasing supply but in a decreasing way. Most of the currencies or commodities that we use as a wealth transfer mechanism does not have that kind of unique aspect so in this way Bitcoin is a stronger candidate for a sound medium of exchange.

2.3.3.3. Peer to Peer Transactions and Distributed Ledger Technology

As Nakamoto (2008) declared in Bitcoin's white paper, in Bitcoin ecosystem transactions are peer to peer meaning that there is no other financial intermediary acting as a trust mechanism. In exchange for financial intermediaries, there are miners approving transactions and forming blocks by solving mathematical formulas which is called 'proof of work'. By such a system, users do not need banks anymore. Besides, their transactions are not visible to any banking accounting ledgers. Users, in another words, senders and receivers of Bitcoins are able to form transaction mechanism directly and peer to peer.

Distributed ledger technology, on the other hand is based on nodes all over the world which store blockchain data. These data is like a ledger of Bitcoin ecosystem. So, with distributed ledger technology there are thousands of ledgers which are kept all over the world instead of banking registrations.

2.3.3.4. Pseudonymity

In Bitcoin ecosystem, accounts are not linked with real people's names. In the ecosystem, an account owner is not known or seen. However, despite account owners are not known, accounts information, basically account balance, transaction and transfer history could all be seen in blockchain. That's why by tracking transaction records, a user's real identity might be unlocked. So rather than anonymity, the accounts' privacy might be regarded as pseudonym (Lo and Wang, 2014: 2). Accounts are not visibly linked to real identities but accounts information is all visible on blockchain without its real identity. By searching accounts name which is composed of different numbers and letters, one can have information of that account balance and its transaction record. Despite not demonstrating identities in a visible way, the system is even transparent because all kinds of information about accounts are easily reached.

The state of pseudonymity also takes attention of those who are searching for ways of transferring wealth without sharing identities such as drug dealers, smugglers, terrorists and those dealing with such kind of criminal activities. So, according to some specialists, Bitcoin is a suitable payment option for criminal activities. Some researchers declare that around \$76 billion of illegal activity per year

involve Bitcoin (46% of Bitcoin transactions), which is close to the scale of the US and European markets for illegal drugs (Foley, Karlsen and Putnins, 2018: 1). However, some researchers suggest just the opposite. As an example, 'a special agent with the U.S. Drug Enforcement Administration (DEA) has reportedly revealed that the use of Bitcoin in illegal activities has shrunk to about 10 percent from 90 percent previously. This finding contradicts the popular perception of the 'cryptocurrency's primary use' (Helms, 2018: 1).

2.3.3.5. Divisibility

Divisibility is one of the major characteristics of an ideal monetary medium of exchange. In order for a tool to be used in place of a monetary medium it should be divisible. Most of the monetary instruments were abandoned because they were not divisible such as leather and sea shells. Divisibility of a monetary instrument also enables its users to transport it to remote locations without too much effort. It is much easier to transport something by dividing it without being obliged to carry it as a single piece.

One Bitcoin is composed of 100,000,000 single units which are called satoshi. The word 'satoshi' comes from the name of Bitcoin's creator Satoshi Nakamoto. So, one Bitcoin can be divided to 100,000,000 equal units of value. Today, the value of a satoshi unit is so small that it is not even comparable to the value of one cent. However, thinking in a broader sense, if Bitcoin succeeds and keeps on working in a healthy manner it would inevitably be used more commonly and rise in value. So, if there is a high rise in Bitcoin's value, satoshi units will also become much more valuable and usable. So, due to the maximum number of Bitcoins, the risk of an incredibly high value of Bitcoin does not affect its usage because even if one Bitcoin becomes too valuable in the future it can be divided 100 million small units and does not distort its usage.

2.3.3.6 Security

Because of the fact that Bitcoin and blockchain system do not rely on a trusted third party, security issues about the system are highly debated. First of all, transactions on the Bitcoin ecosystem are irreversible. In other words, once a transaction

is broadcasted to the Bitcoin network and approved by the majority of mining nodes, there is no chance to reverse the operation. Indeed, that feature is coded in the algorithm on purpose to prevent double spending, fraudulent or misleading transactions. As an example, one can send an amount of Bitcoins in exchange for a purchase and after receiving the product he might reverse the previous transaction and receive his funds back.

The decentralized structure of blockchain system is another aspect of the Bitcoin ecosystem which makes it immune to outside attacks. Because of being an alternative and unregulated financial system, government might try to shut down Bitcoin's blockchain system if the system succeeds and grows in marketcap. However, as debated earlier, due to the decentralized structure of the system, nodes located all over the world that are serving as microledgers provide a great protection. Even if governments or any other institution shut down some masternodes, the system keeps on working properly. In order to shut down Bitcoin system permanently, governments have to place a guard in front of each computer node which is impossible.

The act of banning Bitcoin trade and Bitcoin exchanges also is not enough for shutting down Bitcoin system. As an example, China has banned cryptocurrency exchanging and trading platforms in September 2017(Zhang, 2018: 1). As a result of this ban, most of the exchanges moved their operations out of China. However, in order to paralyse Bitcoin system all countries should decide on a consensus and ban those kind of operations collectively. If not, investors can easily send their Bitcoins to another exchange and convert them to USD and send the USD back to their homecountry again. Because it is nearly impossible to ban blockchain system, one can easily send his cryptocurrency funds to another accounts on exchanges operating in countries inwhich Bitcoin is not forbidden.

After 10 years from its invention, despite of all countless attacks on Bitcoin ecosystem, it is working properly without any defaults. Besides, the blockchain software which Satoshi Nakamoto proposed is an open source software so developers are able to include extra developments into the system as long as it is accepted by the majority of the community. So, the system is alive and a progressive system. With

each development in blockchain ecosystem, developers have the chance to improve Bitcoin software with additional patches and improvements.

2.3.3.7. Fast and Inexpensive 7/24 Wealth Transfer

Bitcoin was first introduced as a payment system. So, it can be seen as a form of payment. However, this type of payment mechanism is little different than other forms because the system eliminates the need for a trusted third party as mentioned before. On the other hand, this new form of wealth transfer mechanism has plenty of advantages like being fast, inexpensive and 7/24.

First of all, payments can be executed anytime day and night. One does not need an institution to be working in order to execute a transaction because the system does not rely on a third party to be credible. Instead, some of the computer nodes which are called miners are guards of the system. So 7/24 payment and wealth transfer mechanism brings flexibility to the system.

In proportion to International Wire Transfers, transfers are executed very fast. Forming a block in a blockchain takes 10 minutes on average (Nakamoto, 2008: 4). In order for a transaction to be accepted as credible, forming 3 blocks which takes 30 minutes on average is enough. So, only 30 minutes is needed in order for the two parties to rely on the credibility of the transaction. Thus, in International money transfer alternatives such as SWIFT, the same transaction might take 3 days. Furthermore, it does not have any importance whether the payment is executed between two countries, cities or towns. In Bitcoin's blockchain system every location is just a point on the earth, nothing more. So, while transferring funds, the same commission fee is charged to both international and domestic transfers. Besides, the commission fees are noticeably lower in proportion to especially International Wire Transfers. As an example, at the time of writing, the fastest and cheapest transaction fee is currently 104 satoshis/byte, which is 25792 satoshisequivalently 1,43 USD for the median transactions of 248 bytes(<https://earn.com/>).

CHAPTER THREE

EMPIRICAL ANALYSIS OF CAUSALITY BETWEEN BITCOIN AND OTHER VARIABLES

The purpose of this section is to empirically analyse the causal relationship between bitcoin and other variables such as gold, Japanese Yen, Chinese Yuan and Bitcoin transaction volume. 10 years after bitcoin's invention there is not a detailed literature covering and analysing all aspects of Bitcoin. In this framework, both Bitcoin and its literature is growing due to its popularity.

This research might play an important role to give information about the causality relationship between Bitcoin and gold, Yen, Yuan and Bitcoin Transaction Volume. Moreover, taking into consideration the resemblance of Bitcoin and Gold, the causality relationship between these two assets might help investors to position themselves accordingly. For example, as findings have shown that Bitcoin is a good substitute for gold, the investors can allocate some fraction of their gold portfolio to Bitcoin. This decision might also enable investors to favor rapid price increases of Bitcoin. But on the other hand, it also enables them to hedge their gold portfolio. In addition, as findings in this research have shown, Bitcoin and gold reacts to similar financial indicators. So, in this context, Bitcoin investors might also hedge their portfolios by keeping gold since it is less volatile than Bitcoin. Policy makers should also take this new cryptocurrency into consideration and set up some new regulations to enable investors secure conditions since it has gold characteristics. Rather than banning Bitcoin operations and shutting down exchanges, policy makers should set regulations in order to enable investors and traders to operate in secure and healthy environments.

According to findings in this research, there is also a negative causality relationship between Bitcoin and Japanese Yen and also Chinese Yuan. So, in the light of this finding, Yen and Yuan investors might allocate minor portions of their portfolios to Bitcoin. Keeping Bitcoin will help them to hedge their Yen portfolios and on the other hand they might also favor rapid price increases of Bitcoin since it is a very volatile instrument.

Chinese government banned Bitcoin trade in the year 2018 in order to prevent capital flow out of the country. However, the biggest Bitcoin mining firms are

operating in China. After the prohibition of Bitcoin trade, mining firms started to move their operations out of the country. Policy makers in China should maintain transparent and safe environments for Bitcoin traders and miners rather than banning since mining new Bitcoins enables USD flow in Chinese economy.

3.1. LITERATURE REVIEW

Eventhough Bitcoin is a newborn cryptocurrency, there are several researches in the literature. Generally, the diversification of portfolios by using Bitcoin in order to hedge risks were tested. Several researches below show that allocating small fractions to Bitcoin might help to diversify portfolio's risks. Moreover, the relationship between Google searches and Bitcoin was also analysed. As stated below, test results have shown that there is one way causality from Google searches to Bitcoin price indicating that price of Bitcoin increases as Bitcoin curiosity and popularity among investors increase. However, according to the results of previous researches no relationship was found between Bitcoin and BIST100, FTSE100, and NIKKEI225 indices. In addition to this, researches found that Bitcoin possess some of the same hedging abilities as gold. Furthermore, a research below indicate a causality from Bitcoin to interest rates in Turkey.

Briere, Oosterlinck and Szafarz (2013) analysed whether bitcoin investment offers significant diversification benefits or not. They used weekly data from 2010 to 2013. In the research mean-variance spanning tests were applied. The situation of an investor holding both traditional and alternative assets was examined. The results have shown that even the inclusion of a minor portion of Bitcoins could improve the risk return trade off of well diversified portfolios. On the other hand, Dyhrberg (2016) analysed the relationship between Bitcoin, gold and the US Dollar within a GARCH framework. Daily data of Bitcoin price, gold bullion price, CMX Gold Future price, dollar-euro, dollar-pound exchange rate and Financial Times Stock Exchange Index from 19.07.2010 to 22.05.2015 was tested. His findings showed that Bitcoin might be used to hedge risks in portfolios and ideal for investors when there are negative shocks in the market. Duluþçu, Yiyit and Genç (2017) analysed whether the price formation of Bitcoin depends on its popularity or not by using Variance Decomposition Analysis based on VAR Model and Granger Causality Test.

According to test results, there is a one way causality relationship from the number of Google searches to Bitcoin price. In other words, the interest towards Bitcoin will effect its price. Furthermore, Eyuboglu (2018) examined the day of the week and month of the year effects in Bitcoin and Litecoin markets using GARCH(1,1) model. It was found that Monday, Tuesday and Friday have significant positive effects on Bitcoin and Saturday has negative effect on Litecoin returns. On the other hand February, October and November have significant and positive effect on Bitcoin and August have significant negative effect on Litecoin returns in terms of month of the year effect. Canoz and Dirican (2017) tested whether Bitcoin prices have an effect on investor decisions in stock market transactions by using ARDL boundary test method. According to test results, cointegration relationship between BTC prices and US and Chinese stock market indices is observed and any relationship could not be found with BIST100, FTSE100 and NIKKEI225 indices. Authors propose that investors in stock markets might be influenced by Bitcoin prices in the long term. Moreover, developing indexes for cryptocurrencies and recording statistics in the context of Central Bank regulations are suggested.

Icelliglu and Ozturk (2018) studied the relationship between exchange rates such as US Dollar, Euro, Pound, Yen and Yuan by using Engle Granger Cointegration, Johansen Cointegration and Granger Causality Tests. The test results have shown that there is no long or short term relationship between Bitcoin and US Dollars, Euro, Pound, Yen and Yuan. According to them the currency of the future will be an electronic one possessing all features of Central Bank money. So, by fiscal regulations central banks should form a monetary system that satisfies today's monetary demand. Atik, et. al. (2015) tested whether Bitcoin has a relationship between frequently used exchange rates by using Granger Causality and Johansen Cointegration Test. Daily data from 2009 to 2015 is tested. According to test results, there is a one way causality relationship from Japanese Yen to Bitcoin. Regulations by Japanese Government about cryptocurrencies might explain this causality relationship. In addition to this, authors propose that the reason that Japan is the first country enabling Bitcoin's use in financial world could also help explain such relationship. Bouoiyour, et. al. (2016) tried to assess the issue of Bitcoin price formation by using a new technique called Empirical Mode Decomposition (EMD).

Results have shown that Bitcoin price is extremely driven by long term fundamentals (above one year).

Dyhrberg (2016) has accomplished a research to explore the hedging capabilities of Bitcoin. In order to do that he applied asymmetric GARCH methodology used in investigation of gold. According to test results, Bitcoin might be used as a hedge against stocks in the Financial Times Stock Exchange (FTSE) Index. Moreover, Bitcoin can be used as a hedge against USD in the short term. Taking everything into consideration, Bitcoin possess some of the same hedging abilities as gold. Furthermore, Ciaian, et. al. (2016) studied Bitcoin price formation by considering the traditional factors such as currency price, market forces of supply and demand and some specific factors such as Bitcoin attractiveness for investors and users. According to test results market forces and Bitcoin attractiveness for investors and users have a significant impact on Bitcoin price but with variation over time. Given that Bitcoin supply is exogenous, demand side drivers will be crucial drivers in future. In addition to this, researchers propose that global macro-financial development may not be driving Bitcoin price. They also conclude that movements in Bitcoin price does not make it a good candidate for a healthy monetary medium.

On the other hand, Szetela, et. al. (2016) searched for the relationship between the exchange rate for Bitcoin to the leading currencies such as USD, Euro, British Pound, Chinese Yuan and Polish Zloty. In the study ARMA and GARCH models were applied. According to test results, there is a dependency in explanation conditional variance between Bitcoin and USD, Euro and Yuan but on the other hand there is no relationship between Bitcoin and other dependent variables. However, results have shown that Bitcoin/Polish Zloty currency pair is not fully independent from external sources and it can be influenced by third party agents. So speculators might obtain huge gains. Furthermore, Güleç and Çevik(2018) studied the relationship between Bitcoin and foreign Exchange, stock, commodity markets and interest rates. In order to do such a research, Johansen Cointegration and Granger Causality tests were applied to data between March 2012 and May 2018. Test results have shown that there is a statistically significant relationship between interest rates and Bitcoin prices and it was found that Bitcoin Granger causes interest rates.

According to research, the presence of a relationship between Bitcoin and interest rate in Turkey has shown that interest rates are generally global indicators.

Erdas and Caglar (2018) studied the relationship between Bitcoin and exchange rate, commodities and global indexes by using asymmetric causality test. According to the results, from Bitcoin prices to S&P 500 Index there is one way causality. So investors in S&P 500 market should monitor Bitcoin prices. Authors suggest that most of the investors in S&P 500 market have enough information about Bitcoin ecosystem and follow technological improvements. Moreover, researchers also expect that Bitcoin might be an accepted currency worldwide. Carrick (2016) researched the value and volatility of Bitcoin relative to emerging market currencies and explore ways in which Bitcoin can complement emerging market currencies. According to test results, Bitcoin can complement other currencies especially currencies of those emerging markets. In addition to this, the uncertainty of Bitcoin could be minimized whereas benefits could be maximized. Furthermore, Kocoglu, et. al. (2016) analysed the efficiency, liquidity and volatility of Bitcoin markets. Cointegration and Granger Causality tests, Vector Error Correction Model (VECM) and Var Model were applied. The results have shown that except Okcoin Bitcoin Market, all markets included in the research are cointegrated and move in the same way in the long term. According to the research, volatility of Bitcoin is enormously high in proportion to selected currencies and gold making it highly risky for investors. Authors also propose that despite rising interest towards Bitcoin, it is not a mature financial instrument so it is very early to regard it as a safe haven for investors. Agan and Aydın (2018) on the other hand, analysed asymmetric causality relation between Bitcoin and some selected exchange rates. In the research, investigation was done by using Hatemi-J method. According to the results, analysis has shown that one way shocks were found between Bitcoin and Yen, Yuan, Canadian Dollar and American Dollar, however there is no one or two way causality relationship was found between Euro and British Pound. Increases in the exchange of Bitcoins, legal and tax regulations enable Bitcoin trade in such markets leading to a relation with local currencies. According to researchers, as long as there is a preference towards electronic money, even if Bitcoin can not succeed, cryptocurrencies and blockchain will play an important role in future.

Kandemir, et. al. (2018) analysed and tried to explain the fluctuations in the price of Bitcoin by oil prices, speculations and Bitcoin transaction volume. By using Hayes Process test, the results have shown that demand, speculations and oil prices have effected Bitcoin prices in a statistically significant way. Malhotra and Maloo (2014) have made a research to find an evidence if there is a speculative bubble in Bitcoin exchange markets. During the research, sequential unit root tests were employed. The results of such sequential unit root tests demonstrate strong evidence of explosiveness in Bitcoin exchange rates. In other words researchers suggest suspected a bubble in Bitcoin system.

Baur et al. (2018) on the other hand, examined the relationship between Bitcoin and Gold by using the GARCH Volatility analysis. Findings have shown that Bitcoin shows different correlation and volatility characteristics compared to Gold. Selmi et al. (2018) researched the roles of Bitcoin as a safe haven compared to Gold. In order to achieve conclusion he used quantile on quantile regression approach. Findings have shown that Bitcoin offers better divisibility and offers supernormal returns. Besides, Bouoiyour et al. (2019) tested whether Bitcoin might replace Gold as a save haven. In the research a dynamic Markov-switching copula model was used in order to test Bitcoin and Gold in both low and high risk scenarios. Tests results have shown that Bitcoin and Gold behave as complemantary goods rather than substitutes in risky environments.

Dyhrberg (2015) tried to explore hedging capabilities of Bitcoin against stocks in the Financial Times Stock Exchange Index and American Dollar by applying the asymmetric GARCH methodology. His findings suggest that in general sense Bitcoin has high hedging capabilities against the so called index and might be used as a substitute for Gold to minimize market risks. According to Ammous (2018), Bitcoin might be a useful tool for those central banks which face international monetary restrictions and taking into consideration of its scarce supply accumulating in small portions might be beneficiary for central banks in near future.

Furthermore, Briere et al. (2015)analysed the data over 2010-2013 period using spanning tests. Results have shown that allocating even a small fraction of portfolio to Bitcoin may drastically improve risk-return characteristics. Corelli (2018) tested the relationship between Bitcoin and some selected fiat currencies. In

the research, he used Granger Causality Test. Findings propose that there is a bidirectional causality relationship between Bitcoin and Japanese Yen.

Wang and Lee (2011) tested gold's hedging capabilities to Japanese Yen. In order to test this, such a long time period of data including the years 1986 to 2007 was tested. Vector Autoregressive Model was built to investigate the causality relationship between Gold return and Yen depreciation rate. Tests results have shown that, when the depreciation rate of Yen is above some level, investing in Gold could avoid the depreciation loss. On the other hand, Le and Chang (2011) employed bounds testing approach to cointegration to test the relationship between Gold, oil and some selected financial variables such as interest rate, exchange rate, and stock prices. Results have shown that increases in the price of gold depreciate Japanese Yen versus major currencies and authors suggest that the ideal choice for Japanese Yen investors in the long term is to keep Gold in their portfolios.

Folkinshteyn et al. (2015) propose that even if Bitcoin system seems to have no value just because of being an only transmittal system, it might offer a great value by disrupting the existing random payment systems. Matta et al. (2016) studied the relationship between Bitcoin's trading volume and web search. They investigated whether public sentiment, expressed in large-scale collections of daily Twitter posts, can be used to predict the Bitcoin market too. Results have shown that Google Trends is an healthy predictor of Bitcoin Transaction Volume.

Kaminski (2014) analysed correlations and causalities between Bitcoin market indicators and twitter posts. Within a time frame of 104 days 160.000 Twitter posts were included in tests. He used Dynamic Granger Causality test. Moreover, tests results have shown that higher Bitcoin trading volume Granger causes more twitter signals. Sahoo, et. al. (2019) examined linkages between Bitcoin returns and Bitcoin transaction volume. In the research, linear and non linear causality tests were applied. Such research have shown that there is a bidirectional causality between Bitcoin returns and transaction volume. On the other hand Georgoula et al. (2015) applied time series analysis to research the relationship between Bitcoin prices and fundamental economic variables, technological factors and measurement of collective mood derived from Twitter feeds. In the research Vector Error Correction Model was applied. Analysis revealed that Bitcoin price is positively correlated with

the number of Bitcoins in circulation and negatively associated with the Standard and Poor's 500 stock market index. On the other hand according to test results, the price of Bitcoin is positively affected by the number of Wikipedia searches which is exactly a measure of popularity.

3.2. DATA AND METHODOLOGY

In order to analyse the casual relationship between Bitcoin price and those selected variables Continuous Wavelet Transformation Technique is used. Continuous Wavelet Transform (CWT) Granger Causality test is a non parametric causality test which was developed by Olayeni (2015) by employing phase difference function using Rua's (2003) CWT correlation criteria (Rua.2003: 773).

Financial data has a complex structure including sudden changes, oscillations and slowly changing trend components. By using wavelet analysis, time and frequency graphics which enclose changes in data components are generated by dividing such components. Then, analysis of changes in oscillations' time and frequency becomes possible.

Wavelet function is a wave shaped function which has a zero average. By sliding the main wavelet function in time dimension and calculating with each other the below continuous wavelet function is obtained.

$$W_x(s, \tau) = (x * \Psi_{s, \tau})(t) = \int_{-\infty}^{\infty} x(t) \frac{1}{\sqrt{s}} \tilde{\Psi}\left(\frac{t - \tau}{s}\right) dt$$

Where $\tilde{\Psi}(\cdot)$ is a complex conjugate function of $\Psi(\cdot)$. On the other hand, $W_x(s, \tau)$ is the wavelet spectral power of variable x in radian frequencies. τ in the equation represents time.

In this research Morlet Wavelet Function which is a wavelet function revised by using Gaussian Envelope function is employed. The equation of Morlet Wavelet Function is;

$$\Psi(\eta) = \pi^{-1/4} \exp(i\omega\eta) \exp(-\eta^2 / 2)$$

Where η is dimensionless time

The above Continuous Wavelet Function which has a continuous character is divided into sub parts for data analysis and the spectrum is obtained for the data of $\{x_n : n = 1, 2, \dots, N\}$. This is called time-frequency demonstration.

$$W_x^m(s, \tau) = \frac{\delta t}{\sqrt{s}} \sum x_n \tilde{\Psi}\left((m-n)\frac{\delta t}{s}\right), m = 1, 2, \dots, N-1$$

Where tilde on $\psi(\cdot)$ denotes the complex conjugate of function $\psi(\cdot)$, s and τ are the scale and location parameters and δt denote a uniform step size

Wavelet energy spectrum, $|W_x^m(s, \tau)|^2$, detects the changes in time and frequency dimensions of data. The spectrum of x_n and y_n data is equal to covariance matrix in time dimension and defined as $W_{xy}^m(s, \tau) = W_x^m(s, \tau) \tilde{W}_y^m(s, \tau)$. And $\tilde{W}_y^m(s, \tau)$ is a complex conjugate function of $W_y^m(s, \tau)$ function.

The spectrum of each datum is separated into real and imaginary parts by the formula of $W_x^m(s, \tau) = \Re\{W_x^m(s, \tau)\} + i\Im\{W_x^m(s, \tau)\}$ in order to calculate local phase values. Local phase function which is $\phi_x(s, \tau) = \tan^{-1}\left\{\frac{\Im(W_x^m(s, \tau))}{\Re(W_x^m(s, \tau))}\right\}$ gives information about the data between the local phase values. Olayeni (2015) developed the Granger causality test by using Rua's (2003) wavelet correlation function which is given below as;

$$\rho_{xy}(s, \tau) = \frac{\zeta\left\{s^{-1}|\Re(W_{xy}^m(s, \tau))|\right\}}{\zeta\left\{s^{-1}\sqrt{|W_x^m(s, \tau)|^2}\right\}\zeta\left\{s^{-1}\sqrt{|W_y^m(s, \tau)|^2}\right\}}$$

(Rua, 2003: 773).

In the above function $\zeta(\cdot) = \zeta_{scale}(\zeta_{time}(\cdot))$ with ζ_{scale} and ζ_{time} are the smoothing operators along scale and time axis respectively. Besides, the local phase difference function is;

$$\phi_{xy}(s, \tau) = \phi_x(s, \tau) - \phi_y(s, \tau) = \tan^{-1}\left(\frac{\Im(W_{xy}^m(s, \tau))}{\Re(W_{xy}^m(s, \tau))}\right)$$

The total phase range, $-\pi \leq \phi_{xy}(s, \tau) \leq \pi$, can be separated into 4 sub interval parts which has lead and lag relationship and direction of causality. $\phi_{xy}(s, \tau) \in (0, \pi/2)$ interval shows an in phase relationship and Y leads X. An inphase relationship

informs that both data move in the same direction. Furthermore, in the $\phi_{xy}(s, \tau) \in (-\pi, -\pi/2)$ interval there is an out of phase relationship between X and Y where Y leads X. Out of phase relationship is a relationship where data moves in opposite ways. Moreover, $\phi_{xy}(s, \tau) \in (-\pi/2, 0)$ interval includes an in phase relationship as a leader of X whereas in the interval $\phi_{xy}(s, \tau) \in (\pi/2, \pi)$ there is an out of phase relationship and X leads Y. In the Granger Causality Test which is based on Continuous Wavelet Transformation, causality and noncausality movements are differentiated. Indicator function takes the value of 1 on the spesific phase interval and 0 otherwise. By doing that, some measures can be taken for the direction of causality and lead and lag relationship. The function below shows the relationship where Y leads X in an in phase relationship.

$$I_{Y \rightarrow X}(s, \tau) = \begin{cases} 1, & \text{if } \phi_{xy}(s, \tau) \in (0, \pi/2) \\ 0, & \text{otherwise} \end{cases}$$

Thus, Continuous Wavelet Granger Transformation Test including an in phase relationship Y leading X is ;

$$G_{Y \rightarrow X}(s, \tau) = \frac{\zeta \left\{ s^{-1} \left| \Re \left(W_{xy}^m(s, \tau) \right) I_{Y \rightarrow X}(s, \tau) \right| \right\}}{\zeta \left\{ s^{-1} \sqrt{|W_x^m(s, \tau)|^2} \right\} \zeta \left\{ s^{-1} \sqrt{|W_y^m(s, \tau)|^2} \right\}}$$

As a result, in Continuous Wavelet Transformation Tests, causality relationship can be analysed in time and frequency domain and consequently the causality relationship can be analysed indepth in proportion to the standard causality tests. Moreover, CWT enables to analyse changes in time domain besides frequency domain because it uses Continuous Wavelet Transformation instead of Fourier Transformation. In addition to this, by eliminating the need to apply Wilson transformation, the converging obligation in forecasting is no more present leading to an effective solution. Furthermore, because of being a non parametric test there is no need to calculate lag values in autoregressive modelling. Thus, spurious regression

which might emerge because of misidentifying lag number in data with a long memory is no more present.

As stated above , in this research the causality relationship between Bitcoin price and those selected variables are examined by using Continuous Wavelet Transformation Test. The aim of the research is to find a causality relationship between Bitcoin and Bitcoin Transaction Volume, Gold, Yuan and Yen. So, the null hypothesis $H(0)$: There is a causality relationship between Bitcoin and Bitcoin Transaction Volume, Gold, Yuan and Yen. According to test results bidirectional causality relationships were found between selected variables. In the research, daily return series were used by calculating the change in natural log prices such as $Irt = \log (P(t) / P(t-1))$. In the equation $P(t)$ are current prices, whereas $P(t-1)$ are prices of the day before. In the analysis MATLAB program was used. The research daily data covers the period which is between 29.04.2013 – 19.10.2018. Data showing Bitcoin price and transaction volume is obtained from the site www.coinmarketcap.com. Furthermore, gold price data is obtained from World Gold Council.Data, covering the exchange rate of Chinese Yuan, Japanese Yen belongs to International Money Fund. Descriptive statistics of return series are presented in Table 3.

Table 3: Descriptive Statistics

	IRBTC_...	IRGOLD_P...	IRTRANSA...	IRJPY	IRYUAN
Mean	0.001937	-0.000286	0.002468	-0.000183	-9.44E-05
Median	0.001995	-0.000197	-0.014781	-0.000187	-7.54E-05
Maximum	0.357451	0.048387	2.491673	0.030563	0.011033
Minimum	-0.266198	-0.060238	-1.663444	-0.038503	-0.018403
Std. Dev.	0.043884	0.009228	0.397095	0.005813	0.001853
Skewness	-0.182230	-0.034736	0.487210	0.106058	-1.785598
Kurtosis	10.99328	6.975127	5.301210	7.201362	22.88551
Jarque-Bera	5335.446	753.4413	457.1907	735.8768	16837.71
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	3.874816	-0.327706	4.335580	-0.182452	-0.093434
Sum Sq. Dev.	3.849660	0.097326	276.8943	0.033694	0.003396
Observations	2000	1144	1757	998	990

According to descriptive Statistics in Table 3, the standard deviation of Bitcoin Price and Bitcoin Transaction Volume has notably high values. Besides, there are great differences between maximum and minimum values of these variables which show that both Bitcoin Price and Transaction Volume is so volatile. Moreover, Bitcoin Price, Gold Price and Chinese Yuan are negatively skewed and have long left tail indicating that these series have more lower values than sample mean whereas Bitcoin Transaction Volume and Japanese Yen are normally skewed meaning that the distribution is symmetric around its mean. On the other hand, all variables possess a leptokurtic behavior and have fat tails and peakedness since kurtosis values are greater than 3.

3.3. EMPIRICAL FINDINGS AND POLICY IMPLICATIONS

In this research, the causality relationship between Bitcoin and other selected variables such as Japanese Yen, Gold, Bitcoin Transaction Volume and Chinese Yuan is examined using MATLAB program in the period between 29.04.2013 and 19.10.2018. Besides, while testing the causality relationship Continuous Wavelet Transformation Technique is used. This technique is however, significant because by using the technique CWT, the causality relationship can be analysed in both time and

frequency domain and researchers have the chance to accomplish an in depth research.

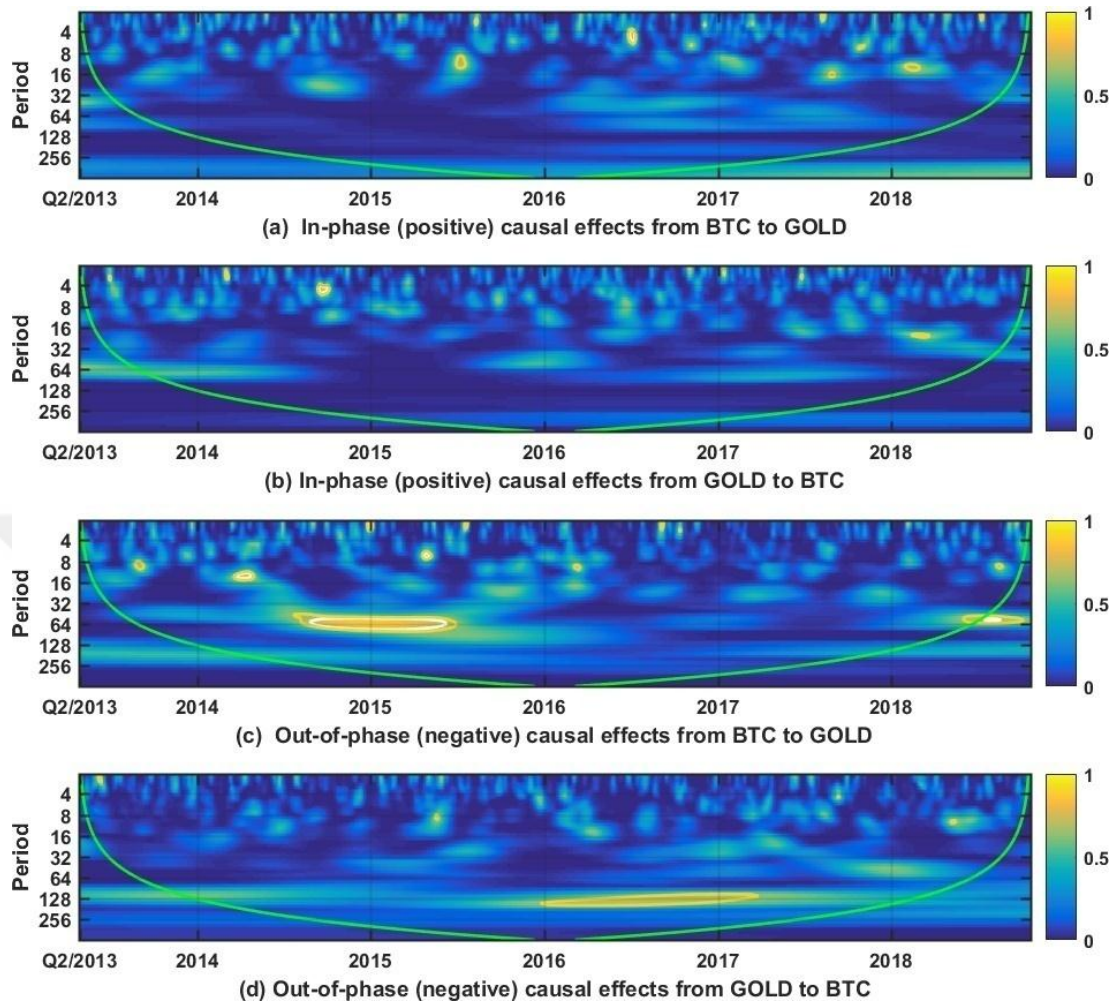
Before testing data by using Continuous Wavelet Transformation Technique, unit root tests were applied. Augmented Dickey-Fuller and Kwiatkowski-Phillips-Schmidt-Shin tests were used during the Unit Root test process. Table 4 demonstrates Unit Root Test results for variables in the research. Results have shown that return series of logarithmic values of variables have no unit root in %1 level.

Table 4: Unit Root Test Results

Variable	ADF	KPSS
IRBTCPRICE	-44.44271***	0.117929***
IRGOLDPRICE	-28.96274***	0.362428**
IRTRSCVOL	-17.57633***	0.062291***
IRYUAN	-22.45714***	0.153710***
IRYEN	-25.83913***	0.078658***

Tests results have shown that there is a significant bidirectional causality relationship between Bitcoin and selected variables which are Gold, Yen, Yuan and Bitcoin Transaction Volume. Figure 14 shows the CWTC causality test results of GOLD AND BTC. Here, an out of phase relationship represents an opposite relationship where the two variables negatively effect each other. As can be seen from the below figure, there is an out of phase causal relationship from Gold to Bitcoin in the period 128 from 2016 to 2017 2nd half which indicates that negative causality exists between the cyclic movements with the approximate period of 128 working days.

Figure 13: Causal Phase Relationship between Bitcoin and Gold



The year 2016 is the year when the value and recognition of BTC started to appreciate. On the other hand, in contrast to findings of Baur et al. (2018) that Bitcoin returns do not exhibit characteristics in line with Gold because of Bitcoin has unique risk return characteristics and different volatility path, findings in this study suggest that Bitcoin is a good substitute for Gold. Besides, as it is argued from the beginning of this study, taking into consideration the fundamentals of Bitcoin such as being free from any nation's interference, limited supply, high stock to flow ratio, this newly investment instrument also resembles Gold. Moreover, findings in this research also comply with Moussa's (2019) who has proposed that although its trading is faster and reactions are quicker, like gold, Bitcoin reacts similar to

financial events and indicators in GARCH models. So, in the specified interval investors who see BTC as a new digital version of Gold might tend to substitute Gold with Bitcoin in their portfolio and invest more on Bitcoin than Gold which leads to a negative relationship from Gold to Bitcoin in such period.

Today, when the financial markets and institutions are evolving into digital ones, investors might prefer Bitcoin instead of Gold because Bitcoin provides better divisibility and offers supernormal returns as Selmi et al. (2018) proposed. With this idea in mind, those investors might keep more Bitcoin and less Gold and might take advantage of probable value appreciation of Bitcoin in near future.

Taking into consideration Figure 14 above, there seems an out of phase relationship from Bitcoin to Gold in the period 64 in 2014 2nd half and 2015 1st half. The period covers 1 year depreciation period after the short price appreciation in the final time of the year 2013. In that bull market, for the first time Bitcoin was recognised and became well known by the masses and its price appreciated 8 fold in just one quarter. After that, in the depreciation period of the Bitcoin price covering 2014 2nd half and 2015 1st half, most investors have lost faith to this newborn instrument. That uncertain situation led investors to incline towards Gold which is a favorable investment instrument especially in such situations where uncertainty is high leading to an out of phase relationship from Bitcoin to Gold. Such finding contradicts with the proposal of Bouoiyour (2019) that both Bitcoin and Gold behave as complementary goods rather than substitutes in risky environments. Indeed, Bitcoin might be a good substitute for Gold because of the specifications such as being traded at high and continuous frequencies with no days where trading is closed and having speed advantages as Dyhrberg (2015) suggested.

Bitcoin, as Ammous (2018) suggested might be a beneficiary tool for central banks facing international restrictions. Especially today, when the reserve currency

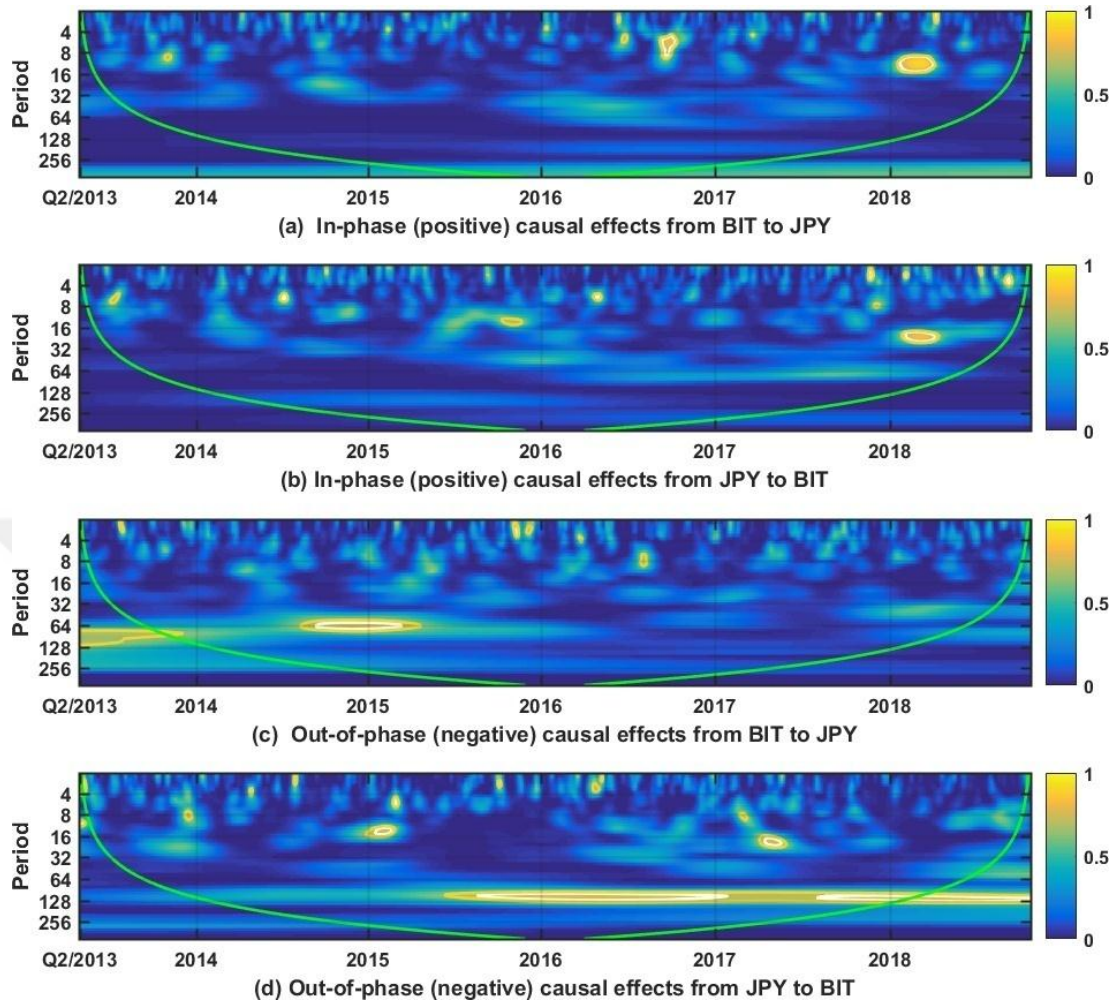
status of the USD is highly debated, the liquidity and ease of transportation of Bitcoin might help most of central banks which are not pleased with the monetary system in the control of United States. Besides, taking into consideration that the supply of Bitcoin is highly limited, it could be a clever act to accumulate a reasonable amount of Bitcoin in case it appreciates significantly in near future.

However, taking into consideration the highly volatile character of Bitcoin, apart from keeping Gold, the individual and institutional investors on the other hand could invest small portions of their portfolios on Bitcoin as a diversification in case of a sudden rise in price of Bitcoin in near future. As Briere et al. (2015) showed allocating even a small fraction of portfolio to Bitcoin may drastically improve risk-return characteristics. Moreover, it would be wiser to invest only a reasonable fraction because of the highly volatile structure of this digital asset.

According to test results, another causality relationship was found between Bitcoin and Japanese Yen. Figure 15 demonstrates causal phase relationship between Bitcoin and Yen after applying CWT. As can be seen below, in accordance with Corelli's (2018) findings stating that there is a bidirectional causality relationship between Bitcoin and Japanese Yen, there is an apparent out of phase or negative causality relationship from Japanese Yen to Bitcoin in periods 64 and 128 from 2015 2nd half till 2018. Furthermore, such findings also are in line with Weng's (2011) conclusions. Weng tested the relationship between Gold prices and some selected exchange rates including Japanese Yen by applying Granger Causality test and found short run relationships between the price of Gold and exchange rates. That period is exactly the period when there was a big Bitcoin rally with a bull market. Japan is one of the countries where Bitcoin's usage and popularity is so high. In this appreciating period of Bitcoin Japanese investors might have chosen Bitcoin just like Gold as an hedge instrument against Japanese Yen. Such conclusion coincide with the finding of

Wang and Lee (2011) who propose that when the depreciation rate of Yen is above some level, investing in Gold could avoid the depreciation loss. Besides, our findings also comply with findings of Le and Chang (2011) who have found that increases in the price of gold depreciate Japanese Yen versus major currencies. Taking everything into consideration, with the popularity of Bitcoin in also mainstream media, investors increased their Bitcoin demand and lowered their Yen demand leading to an out of phase relationship from Bitcoin to Yen. Especially just after Japan accepting Bitcoin and digital currencies as a payment method the causality gained strength. Further research could be done to find out possible explanations effecting Bitcoin and Japanese Yen causality in this defined period.

Figure 14: Causal Phase Relationship between Bitcoin and Japanese Yen



Because of its high volatility, Bitcoin is not considered as a trustable investment instrument according to most investors. So, Bitcoin might be used by professional investors in order to diversify portfolios. Taking into consideration Bitcoin's out of phase relationship with Yen, keeping Bitcoin in small amounts could help to diversify portfolio in a healthy manner, hedge and minimize risks of the investors especially who keep high ratios of Yen. This kind of investment strategy also complies with Le and Chang (2011) proposal which suggest that the ideal choice for Japanese Yen investors in the long term is to keep Gold in their portfolios.

There is also an out of phase relationship from Bitcoin to Yen in period 64 from 2014 2nd half to 2015 2nd half. The bull market which started in 2013 4th quarter continued also in the beginning of 2014. After 2014 2nd half the bear market started that lasted till 2015 2nd half. With bull market which started in the final days

of the year 2013 Bitcoin price rised up to 990 USD from 117 USD making it very popular and well known among investors from Far East Countries. After such a popular period, in the so called bear market period covering the time period from 2014 2nd quarter to 2015 2nd quarter, Japanese investors dumped Bitcoin and invest on more Yen leading to an out of phase relationship from Bitcoin to Japanese Yen.

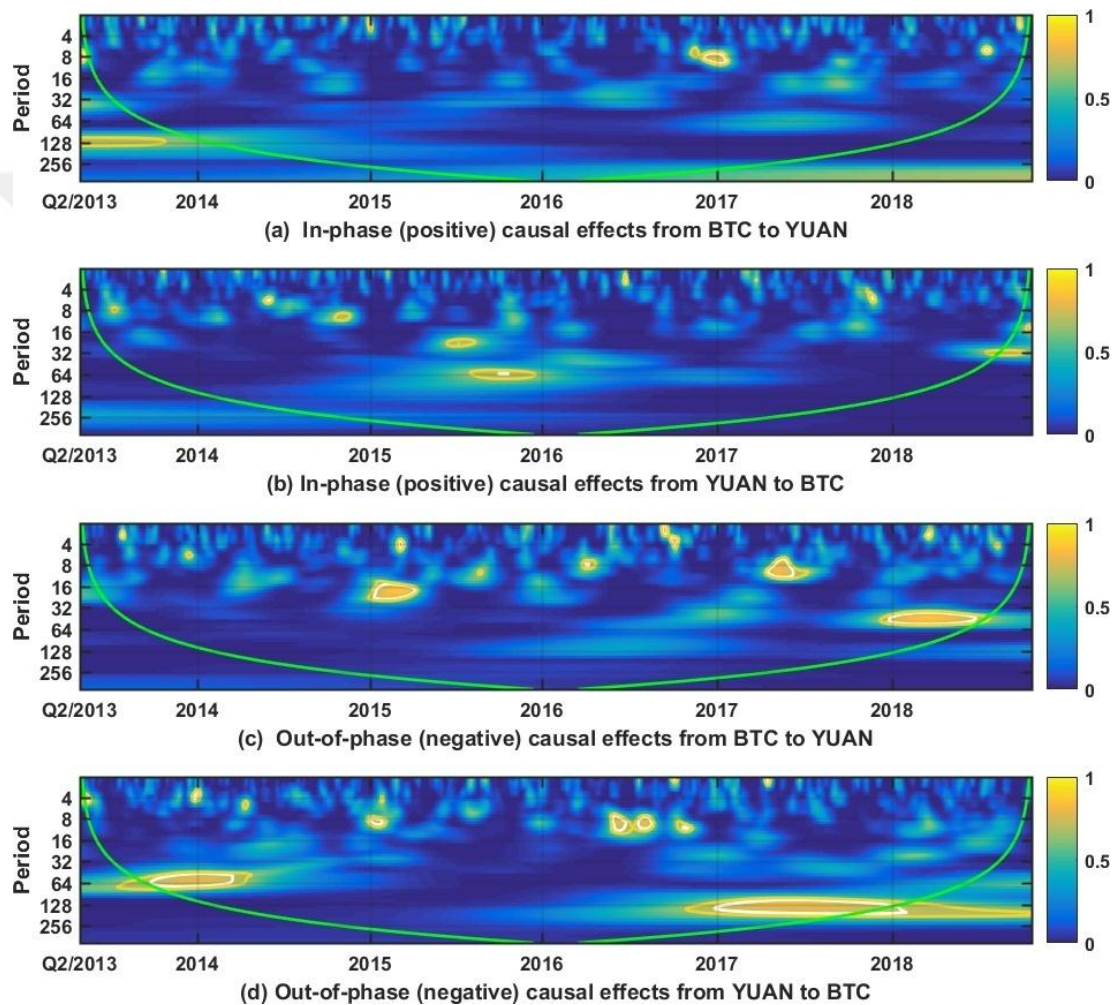
Moreover, according to results there is an out of phase relationship from Yuan to Bitcoin in 2017 period 128 and 256. Bitcoin' price started to rise exponentially in the year 2017 and continued till the end of 2017. In this period Bitcoin's popularity and awareness increased tremendously. Taking into consideration China's totalitarian and bounded economic management, and policies aiming to devaluate Yuan in order to maintain superiority in international trade, massive investments in Yuan in China might be replaced with Bitcoin leading to an out of phase relationship from Yuan to Bitcoin. After banning cryptocurrency trade and Initial Coin Offerings (ICO) officially by Chinese Government in the starting of 2018, investors lost their attention and motivation towards Bitcoin and the causality has ended. The above finding goes in parallel with the related Wall Street Journal news stating that the rise in Bitcoin price has coincided with depreciating Chinese Yuan. Moreover according to the news, Chinese investors have been searching for ways to send money offshore like Bitcoin to eliminate China's capital restrictions. (Vaishampayan et al., 2016)

On the other hand, there is also some strong controversial debate about the effect and causation of Yuan on Bitcoin. Contrary to findings and suggestions in this research, some researchers such as Corelli (2018) was not able to find a causation of Yuan on Bitcoin because of not passing the significance stage of the multivariate regression even if he has found strong effects of Yuan on some other selected cryptocurrencies.

China is one of the countries where Bitcoin trade is extremely popular. At the moment, the biggest mining pools in scale are located in China. Taking into consideration this densely trade volume of Bitcoin and the probability of Bitcoin to become a medium of exchange in near future, China should regulate Bitcoin for a transparent environment rather than banning it. China would favor most in case of regulating Bitcoin, because of returning capital of exchanges into the borders and

more powerful mining firms. Despite some economists who think Bitcoin's risk can not accurately quantified and therefore should be avoided, in our opinion it is worth investing at least in small amounts. (Folkinshteyn et al., 2015: 118) Besides, in case of a drastic depreciation of Yuan because of trade wars going on today, investors should add Bitcoin to their portfolios. Bitcoin, as an anti inflationist store of value would be good option to store wealth.

Figure 15: Causal Phase Relationship between Bitcoin and Chinese Yuan



Moreover, analysing the relationship from BTC to Yuan, there is an out of phase relationship from Bitcoin to Yuan inbetween periods 32 and 64 in the first half of 2018. After 2017 Bitcoin bull run, the bear market started in 2018 after the global decline in Bitcoin popularity. Besides, just in the same period (starting of 2018) the State of China banned trade of cryptocurrencies and Initial Coin Offerings officially. The decline in trust to Bitcoin among Chinese investors and the emerging uncertainty

environment might have led investors to decrease Bitcoin demand and increase Yuan demand leading to an out of phase relationship from Bitcoin to Yuan. Such proposal complies with the Wall Street Journal news indicating that Bitcoin prices have tumbled after Central Bank of China warned investors about the risk of Bitcoin and declared an opinion that financial institutions should not cooperate with firms that are in touch with Bitcoin related operations. (Deng and Sidel, 2013) In addition, Chinese government signaled to abandon policies to depreciate Yuan in order to boost internal demand so Chinese investors could have seen a probable value increase in near future and prefer Yuan rather than BTC as a feasible investment option.

Finally, according to test results there is an inphase (positive) relationship from Bitcoin Transaction Volume to Bitcoin price in between period 64 and 256 in 2016. Figure 17 demonstrates the causal phase relationship between Bitcoin Transaction Volume and Bitcoin price which was 425 USD in the first days of 2016 became 970 USD at the end of 2016 and doubled in price.

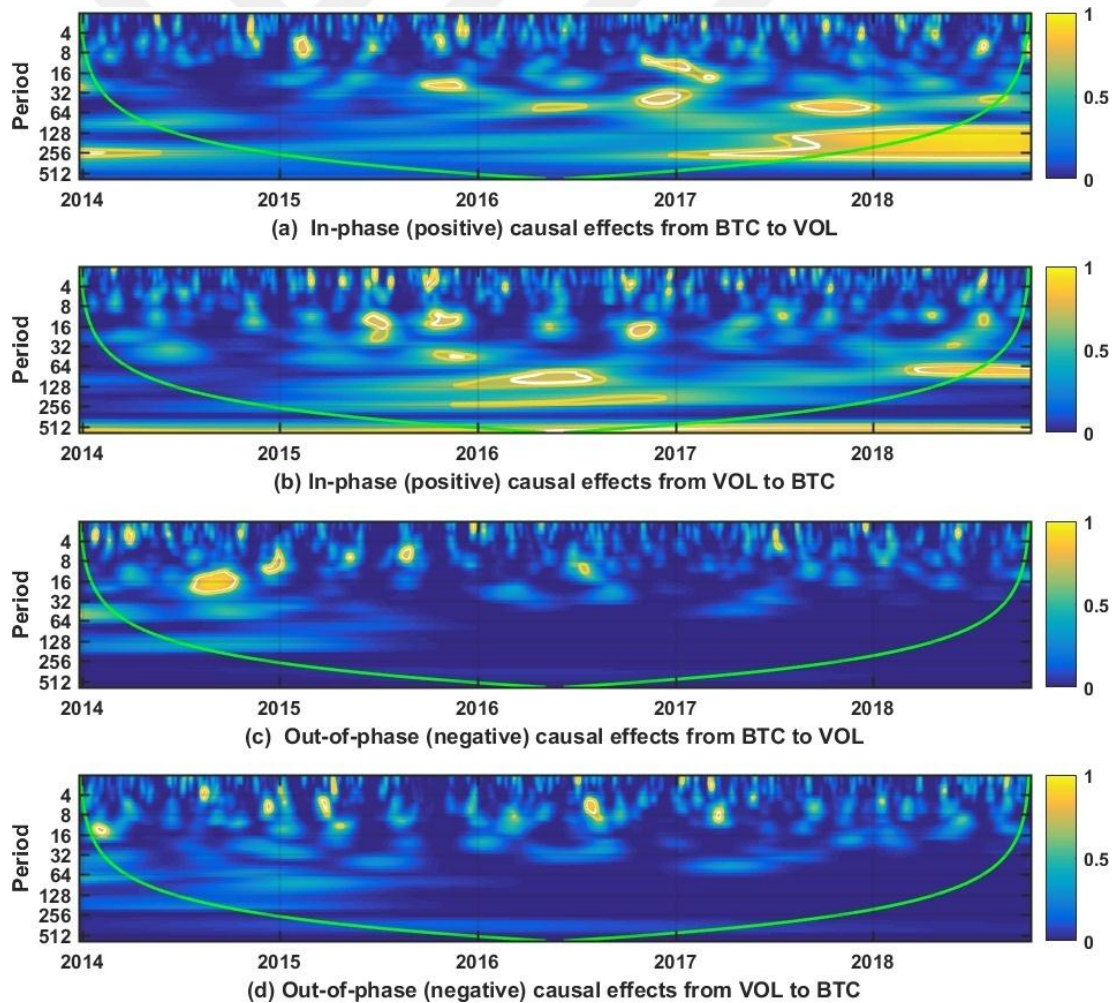
However, according to Figure 17, it is apparent that there is also an inphase relationship from Bitcoin to Transaction Volume in between periods 128 and 256 in 2017. In the year 2017, the bull run and rising Bitcoin prices drove investors to invest on BTC in the mood of 'not to miss the train' which leads to an inphase relationship from Bitcoin to Bitcoin Transaction Volume in the end.

As Matta et al. (2016) found, Google Trends is a healthy predictor of Bitcoin Transaction Volume, Bitcoin Transaction Volume is highly dependable to its popularity. Taking into consideration that this asset might be classified as a digital asset, it is not a surprise that its popularity should be also a web or social media based popularity. On the other hand, Kaminski (2014) proposed that higher trading volume of Bitcoin Granger causes more twitter signals. So, there is a bidirectional causality in between Bitcoin price and its internet based popularity. Taking into consideration that transaction volume is somehow parallel with its popularity, growing popularity and transaction volume of Bitcoin might cause an increase in its price and on the other hand increasing prices also causes its popularity and transaction volume to increase over time. This finding is also parallel with findings

of Sahoo et. al. (2019) who have found that there is a bidirectional causality between Bitcoin returns and transaction volume.

Moreover, Bouoiyour and Selmi (2015) propose that Bitcoin is highly correlated to speculative behaviours. Therefore, popularity of this cryptocurrency is highly influential to its price. As the popularity increases, price increase follows and after an increase in price, increasing popularity comes after. Such a loop continues several times especially during specific Bitcoin rally. Findings of this research also comply with findings of Georgoula et al. (2015) indicating that the price of Bitcoin is positively affected by the number of Wikipedia searches which is exactly a measure of popularity. Further research could be done in order to detect other probable underlying factors effecting price and transaction volume relationship.

Figure 16: Causal Phase Relationship between Bitcoin and Transaction Volume



CONCLUSION

Taking everything into consideration, after Satoshi Nakamoto proposed this newly Bitcoin technology in the year 2008, the financial world has welcome a different kind of payment method where there is no intermediaries such as banks. For most of the economists, the timing of invention which was just in the middle of one of the biggest global crises in the world was no coincidence. At that time of the global crises, the general trust to banks and such financial intermediaries were all time low. So, Bitcoin was proposed as an alternative way to this so called 'corrupted financial environment'.

This proposed 'nationless payment method' gained too much attention from all kinds of individuals especially those who call themselves cyberpunks. Those group refuses the corrupted financial intermediaries and Central Banks which are the institutions controlling the monetary power. Besides, those group believe that those institutions are the main causes of financial crises in modern global economies.

Despite massive debates about this new monetary instrument, Bitcoin has favorable properties such as limited supply, being nationless, divisibility, transportation, ease of storage and pseudonymity which makes it an ideal candidate to become a medium of exchange. However, to become a medium exchange a monetary instrument or commodity has to be a good store of value. According to most Bitcoin supporters, its limited money supply makes it a good store of value at least in the long run. But taking into consideration Bitcoin's lifespan, it has very up and downs in a very volatile range which brings a lot of question marks to become a good store of value in the long run.

Researching Bitcoin and its environment gives us the chance to analyse Bitcoin's properties detailly. Although there are several researches, this newborn payment method is not well known and has a limited use. In proportion to commodity money such as gold, Bitcoin has a very fresh history. Moreover, despite its negative attributes such as being highly volatile, Bitcoin has a great potential and a lot to offer in future if it becomes well known and widely used.

One of the main benefits of Bitcoin is that the market is open 7 days and 24 hours since it does not need any financial authorization and approval mechanism due to its decentralized structure. As mentioned above, apart from widely used value

transfer systems, users can send and receive Bitcoin any time they like with especially very low costs. This attribute is highly practical and suitable for especially in electronic and international trade. Because of the 7/24 nature of Bitcoin ecosystem it eliminates problems arising from the time difference between the traders in different locations of the world. As an example one party who is in Europe can transfer funds directly to the other party located in China without a problem arising from time difference. Moreover, as mentioned above, the cost of sending funds is extremely low in proportion to general transfer methods such as SWIFT. Besides, Bitcoin transfer can be accomplished in minutes whereas it takes up to 3 days in SWIFT system.

Because of the ease of transfer of Bitcoin as Ammous (2018) suggested, it can be very practical for Central Banks for setting its balances and payments. Central Banks generally accomplish this process by using USD and Gold. Even today, value transfer is done physically by transferring Gold by planes. This is a highly costly and risky way in 21st century where most of the operations are done in electronic environments. Rather than moving all those funds physically between the countries' Central Banks, any amount of value could be easily transferred by using Bitcoin. This kind of an operation is much safer and less costly. Besides, carrying funds physically takes enormous time whereas it takes only minutes to transfer the exactly same amount by using Bitcoin. Moreover, since storing Bitcoin is practical, Central Banks do not need guarded and well protected places to store physical assets such as Gold. All they need is a server and e wallet to store Bitcoin funds.

This study aims to increase Bitcoin's awareness among investors and financial authorities. Especially, investors are searching ways to protect their savings value after the drastic depreciation in value of Turkish Lira. When its historical price is analysed in detail, it can be seen that Bitcoin is a highly volatile instrument. However, taking into consideration its limited supply, it can be a beneficiary investment instrument in the long term. At least keeping Bitcoin as a small fraction of portfolio might help Turkish investors to favor probable rapid price appreciation in future.

Apart from being an investment instrument, Turkey and its citizens might also favor by setting up large mining firms in order to mint new Bitcoins. In order to

do that, as mentioned above in 'Miners' section in Bitcoin ecosystem, powerful computers are needed with high technology graphic cards. In order to approve transactions and allocate them into blocks the blockchain algorithm requires a complex mathematical formula to solve. In this system, miners are always competing with each other to be the first one to solve the formula to approve transactions and get the recently created Bitcoins as a reward. Powerful computers with advanced graphic cards are main units of mining firms because in order to mint new Bitcoins fast supercomputers are needed to solve complex formulas of Bitcoin algorithm. When these formulas are solved, transactions of Bitcoin between parties are approved and formed in blocks as a chain which is called Blockchain. In exchange for that process, miners get these recently created Bitcoins as a reward. This process is also the only way to increase the Bitcoin monetary supply.

In today's economy mining Bitcoins is just like digging for oil and gas. Once success has been achieved, it enables huge amount of foreign money such as American Dollars to flow into the domestic economy. Taking into consideration of current account deficit, each USD moving into economy has great importance. One of the main difficulties to mine Bitcoin is that mining consumes great energy as explained above. However, Turkey has a lot of hydroelectric, solar and wind plants which may fulfill the energy needed to mine Bitcoins. So, such kind of an action will enable to exchange countries' natural resources with American Dollars without any trade.

The most important core competence of Bitcoin is that Bitcoin ecosystem works on a recently founded technology called Blockchain. The Bitcoin system operates on a peer to peer network as a decentralized way. By doing that, users do not need 3rd parties to confirm transactions such as banks or other financial intermediaries. Instead, miners do that job. Besides, Bitcoin has no headquarters or such central operating locations since it is decentralized and has masternodes located all over the world.

The system is designed to work 7 days and 24 hours. So a user can send and receive funds in any hour in any day of the week. In addition to this, since nodes and users have no nationality, there is no difference to send funds in the country or abroad. Taking into consideration highly charged fees while sending funds abroad, the network fees of Bitcoin ecosystem is very affordable. Besides, this technological

innovation left no space for governments to interfere capital movements since Bitcoin ecosystem constituted a parallel environment. Theoretically, a user can send million even billion dollars in just one transaction without any blockage. On the other hand, this aspect of Bitcoin attracted attention of those who are dealing with criminal activities and those interested in money laundering. Since governments have no control over the system, those parties have more tendency to use this cryptocurrency.

In this research, the causality relationship between Bitcoin and selected variables such as Gold, Bitcoin Transaction Volume, Japanese Yen and Chinese Yuan were tested. In order to do that MATLAB programme was used. Besides, in the research daily data covering the period between 29.04.2013 and 19.10.2018 was used. According to the research and findings there is a bidirectional out of phase causality relationship inbetween Bitcoin and Yen, Yuan and Gold in some spesific periods and time intervals. However, there is a bidirectional inphase causality relationship between Bitcoin and Bitcoin Transaction Volume in some intervals.

Apart from the analysed technical demand, Bitcoin's demand which pushes its price all time high mostly derives from psychological motives. Moreover, at the moment this recently invented investment intrument has no deep financial roots. In additon to this, it has not an enormous marketcap large enough to absorb outside shocks such as exchanging a large amount of fund which suddenly depreciates its value. The investment instruments which are radically effected by speculative and psychological movements are so volatile and have so many up and downs. Investors should be cautious investing on such funds because especially in the short run they may end up huge losses. Like gold, investors should invest on Bitcoin only for long run and they should not invest more than they could not afford to lose. Apart from bringing a high profit, such highly volatile investment instruments might sometimes lead to huge losses in the end.

REFERENCES

- Aalbers, M. B. (2008). The financialization of home and the mortgage market crisis. In *The Financialization of Housing*. 12(2): 148-166.
- Agan, B. and Aydın, U. (2018). [www.researchgate.net.https://www.researchgate.net/publication/328278747_Kripto_Para_Birimlerinin_Kuresel_Etkileri_Asimetrik_Nedensellik_Analizi](https://www.researchgate.net/publication/328278747_Kripto_Para_Birimlerinin_Kuresel_Etkileri_Asimetrik_Nedensellik_Analizi), (09.05.2019)
- Ammous, S. (2018). *The Bitcoin Standard*. New Jersey: John Wiley & Sons, Inc.
- Angel, J.J. and McCabe, D. (2014). [https://www.ssrn.com.https://ssrn.com/abstract=2379233](https://www.ssrn.com/abstract=2379233), (23.03.2019)
- Ankalkoti, P. and Santhosh, S. G. (2017). A Relative Study on Bitcoin Mining. *Imperial Journal of Interdisciplinary Research*. 3(5): 1362-2454.
- Atik, M., Kose, Y., Yılmaz, B. and Sağlam, F. (2015). Crypto Currency: Bitcoin and Effects on Exchange Rates. *Bartın Universitesi I.I.B.F. Dergisi*. 6(11): 247-261.
- Baur, D.G., Dimpfl, T. and Kuck, K. (2018). Bitcoin, Gold and the Dollar – A Replication and Extension. *Finance Research Letters*. 25: 103-110.
- bitconity. data.bitconity.org, (08.04.2019).
- Bouoiyour, J. And Selmi, R. (2015). What Does Bitcoin Look Like. *Annals of Economics and Finance*. 16(2): 449-492.
- Bouoiyour, J., Selmi, R., Tiwari, A.K. and Olayeni, O.R. (2016). What Drives Bitcoin Price?. *Economics Bulletin*. 36(2): 843-850.
- Bouoiyour, J., Selmi, R., Wohar, M. (2019). Bitcoin: competitor or complement to gold?. *Economics Bulletin*. 39(1): 186-191.
- Briere, M., Oosterlinck, K. and Szafarz, A. (2015). Virtual Currency, Tangible Return: Portfolio Diversification with Bitcoins. *Journal Asset Management*. 16(6): 365-373.

- Cai, C. W. (2018). Disruption of financial intermediation by FinTech: a review on crowdfunding and blockchain. *Accounting & Finance*. 58(4): 965-992.
- Carney, M. (2018). <https://www.bankofengland.co.uk>.
- <https://www.bis.org/review/r180323a.pdf>, (23.03.2019).
- Carrick, J. (2016). Bitcoin as a Complement to Emerging Market Currencies. *Emerging Markets Finance & Trade*. 52(10): 1-14.
- Ciaian, P., Rajcaniova, M. And Kanacs D. (2016). The Economics of Bitcoin Price Formation. *Applied Economics*. 48(19): 1799-1815.
- coinmarketcap. www.coinmarketcap.com, (08.04.2019).
- Corelli, A. (2018). Cryptocurrencies and Exchange Rates: A Relationship and Causality Analysis. *Risks*. 6(4): 111.
- Çarkacıoğlu, A. (2016). <https://www.spk.gov.tr>.
<http://www.spk.gov.tr/siteapps/yayin/yayingoster/1130>, (25.03.2019).
- Deng, C. And Sidel, R. (2013). *Wall Street Journal*.
<https://search.proquest.com/docview/1469170174?accountid=10527>,
(05.01.2020)
- Dilek, Ş. (2018). Blockchain Teknolojisi ve Bitcoin. *Analiz*. 1(231): 7-29.
- Dirican, C. and Canoz, I. (2017). The Cointegration Relationship Between Bitcoin Prices and Major World Stock Indices: An Analysis with ARDL Model Approach. *Journal of Economics, Finance and Accounting*. 4(4): 377-392.
- Dulupçu, M.A., Yiyit, M. And Genç, A.G. (2017). The Rising Face of the Digital Economy: The Analysis of Relationship Between the Value of Bitcoin and Its Popularity. *Suleyman Demirel University The Journal of Faculty of Economics and Administrative Sciences*. 22(Special Issue on Kayfor15): 2241-2258.
- Dwyer, G. P. (2014). <https://www.ssrn.com/>. <https://ssrn.com/abstract=2434628>,
(27.03.2019).
- Dyhrberg, A.H. (2016). Bitcoin, gold and the dolar – A GARCH volatility analysis. *Finance Research Letters*. 16: 85-92.

- Dyhrberg, A. H. (2016). Hedging Capabilities of Bitcoin. Is It the Virtual Gold?. Finance Research Letters. 16: 139-144.
- Erdas, M.L. and Caglar, A.E. (2018). Analysis of the Relationships Between Bitcoin and Exchange Rate, Commodities and Global Indexes by Asymmetric Causality Test. Eastern Journal of European Studies. 9(2): 27-45.
- European Central Bank. (2012). <https://www.ecb.europa.eu/https://www.ecb.europa.eu/pub/pdf/other/virtualcurrencyschemes201210en.pdf>, (28.03.2019)
- Eyuboglu, K. (2017). Examining Day of the Week and Month of the Year Effects in Bitcoin and Litecoin Markets. Cankırı Karatekin University Journal of the Faculty of Economics and Administrative Sciences. 8(1): 165-183.
- Ferguson, N. (2018). Paranın Yükselişi. İstanbul: Yapı Kredi Yayınları.
- Foley, S. Karlsen J.R. and Putnins T.J. (2019). Sex, Drugs, and Bitcoin: How Much Illegal Activity Is Financed through Cryptocurrencies?. The Review of Financial Studies. 32(5): 1798-1853.
- Folkinshteyn, D., Lennon, M., Reilly, T. (2015). The Bitcoin Mirage: An Oasis of Financial Remittance. Journal of Strategic and International Studies. 10(2): 118-124.
- Friedman, M. (1971). Government revenue from inflation. Journal of Political Economy. 79(4), 846-856.
- Georgoula, I., Pournarakis, D., Bilanakos, C., Sotiropoulos, D.N. and Giaglis, G.M. (2015). Using time-series and sentiment analysis to detect the determinants of bitcoin prices. Mediterranean Conference on Information Systems.
- Güleç, Ö.F. and Çevik, E. (2018). The Analysis of The Relationship Between Bitcoin and Financial Indicators. Kırklareli Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi. 7(2): 18-34.
- Gültekin, Y. and Bulut, Y. (2016). Bitcoin Economy: Emerging New Sectors of Bitcoin Eco-System and Its Analysis. Adnan Menderes University Journal of Institute of Social Sciences. 3(3): 82-92.

- Güven, V., Şahinöz, E. (2018). Blokzincir Kripto Paralar Bitcoin. Istanbul: Kronik Kitap.
- Hayek, F. (2007). Denationalisation of Money. London: The Institute of Economic Affairs in Association with Profile Books Ltd.
- Helms, K. (2018). <https://news.bitcoin.com/>, <https://news.bitcoin.com/illegal-activity-use-bitcoin-dea-agent/>, (18.04.2019).
- <https://earn.com/>, <https://bitcoinfees.earn.com/>, (25.04.2019).
- Icelliglu, C.S. and Ozturk, M.B.E. (2018). In Search of the Relationship Between Bitcoin and Selected Exchange Rates: Johansen Test and Granger Causality Test for the Period 2013-2017. Revenue and Finance Writings. (109): 51-70.
- Kaminski, J.C. (2014). Nowcasting the Bitcoin Market with Twitter Signals. Collective Intelligence 2014 MIT: 1-16.
- Kandemir, T., Serezli, G. and Kılınç M. (2018) [www.researchgate.net](https://www.researchgate.net/publication/332632110_Kripto_Paralarin_Fiyatindaki_Dalgalanmalara_Etki_Eden_Faktorler_Hayek_s_Process_Makrosu_Ile_Bitcoin_Uzerine_Bir_Analiz), https://www.researchgate.net/publication/332632110_Kripto_Paralarin_Fiyatindaki_Dalgalanmalara_Etki_Eden_Faktorler_Hayek_s_Process_Makrosu_Ile_Bitcoin_Uzerine_Bir_Analiz, (09.05.2019)
- Keynes, J.M. (2003). [https://cas.umkc.edu](https://cas.umkc.edu/http://cas2.umkc.edu/economics/people/facultypages/kregel/courses/econ645/winter2011/generaltheory.pdf). <http://cas2.umkc.edu/economics/people/facultypages/kregel/courses/econ645/winter2011/generaltheory.pdf>, (24.03.2019).
- Kiyotaki, N. Wright, R. (1992). Acceptability, Means of Payment, and Media of Exchange. Federal Reserve Bank of Minneapolis Quarterly Review. 16(3): 18-21.
- Kocoglu, S., Çevik, Y. E. And Tanrıoven, C. (2016). Efficiency, Liquidity and Volatility of Bitcoin Markets. Journal of Business Research Turk. 8(2): 77-97.
- Le, T. Chang, Y. (2011) Dynamic Relationships between the Price of Oil, Gold and Financial Variables in Bhunia and Mukhuti 043 Japan: A Bounds Testing Approach. Munich Personal RePEc Archive. 3(2): 105-114.
- Lo, S. and Wang, J.C. (2014) Bitcoin As Money. Current Policy Perspectives. 14(4).

- Malhotra, A. and Maloo, M. (2014). [www.researchgate.net.https://www.researchgate.net/publication/314735166_Bitcoin_-_is_it_a_Bubble_Evidence_from_Unit_Root_Tests](https://www.researchgate.net/publication/314735166_Bitcoin_-_is_it_a_Bubble_Evidence_from_Unit_Root_Tests), (09.05.2019).
- Matta, M., Lunesu, I. and Marchesi, M. (2016). Is Bitcoin's Market Predictable? Analysis of Web Search and Social Media. *Communications in Computer and Information Science*. 631: 155-172.
- Menger, K. (1892). On The Origins of Money. *Economic Journal*. 2(6): 239-255.
- Mises, L. (2010). *Economic Policy*. USA: Liberty Fund, Inc. Moussa, W. (2019). Dynamic Linkages Among Bitcoin, Gold Prices and Exchange Rates of US Dollar in JPY, GBP and CNY: DCC EGARCH Approach. *Journal of Academic Research in Economics*. 10(2): 239-247.
- Nakamoto, S. (2008). <https://bitcoin.org/>. <https://bitcoin.org/bitcoin.pdf>, (30.03.2019)
- Norry, Andrew. (2018). <https://blockonomi.com>. <https://blockonomi.com/mt-gox-hack/>, (13.04.2019).
- Olayeni, O. R. (2015). Causality In Continuous Wavelet Transform Without Spectral Matrix Factorization: Theory and Application . *Computational Economics*. 47(3): 321-340.
- Phillips, Daniel. (2019). www.beincrypto.com. <https://beincrypto.com/bitcoin-mining-profitability-how-long-does-it-take-to-mine-one-bitcoin-in-2019/>, (10.04.2019)
- Ricardo, D. (1817). *On the Principles of Political Economy and Taxation*. Ontario: Batoche Books
- Rua, A. (2003). Worldwide synchronization since the nineteenth century: A wavelet based view. *Applied Economics Letters*. 20(8): 773-776.
- Sahoo, P.K., Sethi, D. and Acharya, D. (2019). Is bitcoin a near stock? Linear and non-linear causal evidence from a price-volume relationship. *International Journal of Managerial Finance*. 15(5): 533-545.

- Selmi, R. Bouoiyour, J. Mensi, W. And Hammoudeh, S. (2018) Is Bitcoin a hedge, a safe haven or a diversifier for oil price movements? A comparison with gold. *Energy Economics* 74 (C): 787-801.
- Simmons, E. (1947). The Relative Liquidity of Money and Other Things. *The American Economic Review* 37(2): 308-311.
- Smith, A. (2007). [https://www.ibiblio.org.
https://www.ibiblio.org/ml/libri/s/SmithA_WealthNations_p.pdf](https://www.ibiblio.org/ml/libri/s/SmithA_WealthNations_p.pdf),
(26.03.2019).
- Stiglitz, J. (2018). *The Price of Inequality*. Istanbul: İletişim Yayıncılık
- Szabo, N. (2002). Satoshi Nakamoto Institute. <https://nakamotoinstitute.org/>,
(23.03.2019).
- Szetela, B., Mentel, G. And Gedek, S. (2016). Dependency Analysis between Bitcoin and Selected Global Currencies. *Dynamic Econometric Models*. 16: 133-144.
- Vaishampayan, S., Hunter, G. S. and Deng, C. (2016). (Wall Street Journal Online). <https://search.proquest.com/docview/1835930481?accountid=10527>,
(30.12.2019)
- Wang, K.M. and Lee, Y.M. (2011). The Yen for Gold. *Resources Policy*. 36(1): 39-48.
- Weng, Y.W. (2011). Causal Relationship Between Gold Price, Oil Price, Exchange Rate and International Stock Markets. *Prosiding Perkem*. 6(2): 282-291.
- Wicksell, K. (1906). *Lectures on Political Economy*. Trans. Ernest Classen. New York: Kelley
- Zhang, L.(2018). <https://www.loc.gov/>.
<https://www.loc.gov/law/help/cryptocurrency/china.php>, (21.04.2019)

APPENDICES



Appendix 1: Descriptive Statistics and Unit Root Test Results

APP.Table 1: Descriptive Statistics

	IRBTC ...	IRGOLD P...	IRTRANSA...	IRJPY	IRYUAN
Mean	0.001937	-0.000286	0.002468	-0.000183	-9.44E-05
Median	0.001995	-0.000197	-0.014781	-0.000187	-7.54E-05
Maximum	0.357451	0.048387	2.491673	0.030563	0.011033
Minimum	-0.266198	-0.060238	-1.663444	-0.038503	-0.018403
Std. Dev.	0.043884	0.009228	0.397095	0.005813	0.001853
Skewness	-0.182230	-0.034736	0.487210	0.106058	-1.785598
Kurtosis	10.99328	6.975127	5.301210	7.201362	22.88551
Jarque-Bera	5335.446	753.4413	457.1907	735.8768	16837.71
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	3.874816	-0.327706	4.335580	-0.182452	-0.093434
Sum Sq. Dev.	3.849660	0.097326	276.8943	0.033694	0.003396
Observations	2000	1144	1757	998	990

APP.Table 2: Unit Root Test Results

IRBTCPRICE

—		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-44.44271	0.0001
Test critical values:	1% level	-3.433422	
	5% level	-2.862783	
	10% level	-2.567478	
		LM-Stat.	
Kwiatkowski-Phillips-Schmidt-Shin test statistic			0.117929
Asymptotic critical values*:	1% level		0.739000
	5% level		0.463000
	10% level		0.347000

IRGOLDPRICE

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-28.96274	0.0000
Test critical values:	1% level	-3.437748	
	5% level	-2.864695	
	10% level	-2.568504	
		LM-Stat.	
Kwiatkowski-Phillips-Schmidt-Shin test statistic			0.362428
Asymptotic critical values*:	1% level		0.739000
	5% level		0.463000
	10% level		0.347000

IRTRSCVOL

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-17.57633	0.0000
Test critical values:	1% level	-3.433897	
	5% level	-2.862993	
	10% level	-2.567591	
		LM-Stat.	
Kwiatkowski-Phillips-Schmidt-Shin test statistic			0.062291
Asymptotic critical values*:	1% level		0.739000
	5% level		0.463000
	10% level		0.347000

IRYUAN

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-22.45714	0.0000
Test critical values:	1% level	-3.439345
	5% level	-2.865400
	10% level	-2.568882
	LM-Stat.	
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.153710
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

IRYEN

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-25.83913	0.0000
Test critical values:	1% level	-3.439319
	5% level	-2.865389
	10% level	-2.568876
	LM-Stat.	
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.078658
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000