LUISS Guido Carli
LIBERA UNIVERSITÀ INTERNAZIONALE DEGLI STUDI SOCIALI

DEPARTMENT OF IMPRESA AND MANAGEMENT

Master thesis in Global Economic Challenges

Bitcoin: A rival to fiat money or a speculative financial asset?

SUPERVISOR:

Prof. Gianfranco Di Vaio

CANDIDATE:

Paola Ceruleo

653521

CO-SUPERVISOR:

Prof. Giuseppe Di Taranto

Introduction

In the past few years Bitcoin has been an interesting phenomenon in the financial markets. The initial attention was toward the protocol used to operate the system, but after that the interest was focused more on the economic aspects rather than on the cryptographic matters.

Since the Nakamoto's white paper appeared in 2009 the cryptocurrency has received more and more attention. Especially for the upside and downside that characterize its value exchanged for US dollars. In fact it skyrocketed to $1000 in late November and early December 2013. However after the insolvency of one of the biggest exchange, Mt. Gox, the price has been stabilizing and reducing its volatility, reaching almost $500 for bitcoin traded on April 2014. The literature gave constantly attention to the phenomenon, also the biggest financial institutions have published reports about the economic implications coming from this form of virtual currency. The first influent paper has been published by the ECB on October 2012. The European body arose the discussion about how to define the diffusion of the virtual currencies. Bitcoin is not the only cryptocurrency in the town, as some authors stressed, but for sure it is the most adopted. For this reason from the ECB point of view a distinction

between the various forms of coins were needed. But the widespread definition lacked to establish the real function of Bitcoin. Both Bank of America Merrill Lynch and Goldman Sachs investigated whether the virtual currency could be interpreted as money or not. Reaching the same conclusion, Bitcoin is firstly a mean of payment but this is the only element which approaches to the definition of money, while the unit of account and store of value characteristics are not submitted.

In the discussion about Bitcoin, its volatility is the topic that received most attention. Kristoufek (2014) focuses on the possible sources of the price movements utilizing a wavelet analysis, finding that the investors' interest drives the bitcoin prices in both directions. Hence during period of explosive prices the interest plays the role of pushing the price further up, but in rapid declines it drags prices further down.

The same author in an earlier paper describes how the digital currency volatility is correlated to Google trend and Wikipedia, defining it as the network effect.

Buchholz et al. (2012) show that the volatility of the currency rate is itself interconnected to the price developments, highlighting a connection to Bitcoin and assets bubble.

The aforementioned study led some years later to the identification of Bitcoin as an asset rather than a currency, by Glaser et al. (2014).

Therefore a study of the bitcoin prices across platforms has not been made previously. In general a deep scrutiny of the exchanges lacks in the literature, probably because before the closure of Mt.Gox, it had the monopoly of the market, consequently the other actors were negligible.

The combination of attention in the price movements and exchanges trend leads to the thesis topic, that is the use of Bitcoin as a financial tool for arbitrage purposes, for this reason this work aims to focusing on one type of intermediaries the currency exchanges.

The chapter one analyzes the virtual currencies' ecosystem, firstly explaining how the concept of money is changing and how the institutions have lost their role, expression of trust. Secondly a definition of virtual currencies is given, with attention also to the adoption of them in the real world. A preliminary distinction of fiat currency and virtual currency stresses that this phenomena are part of the same world, but with unbridgeable differences. Those are mostly related to the limited supply of the virtual coins that, as a consequence, has drastically changed the way the monetary policy of them is managed. With the exception of Bitcoin, a lot of other types of cryptocurrencies appeared, as Litecoin or Altcoin, to this extent some point of parity and difference between the most famous one and the others will be stressed. The study simple out further attention

on the legal issues connected to the unregulated framework into which this form of money is inserted.

In chapter two the area of study is the peer to peer electronic cash system, as Nakamoto (2009) describes Bitcoin. Trying to delineate the advantages and disadvantages in the usage of this form of payments instead of the traditional one. Furthermore the main uses are scrutinized, as medium of exchange and as store of wealth. The analysis shows how in the future the protocol would pose problems to the major money transfer companies, due to the almost instantaneous transfer of money and to the low transaction fees. The last paragraph deals with a more accurate evaluation of Bitcoin as money, coming to the conclusion that it is used more for speculative aims rather than as a substitute of hard currency.

After this enlightenment the arbitrage opportunities in the Bitcoin market are analyzed in chapter three. To begin with arbitrage in the good market and then on the currency and asset one. Underlining that in this market are not settled futures or forward contracts, the attention is on the spot rate quoted by the currency exchanges. Huge spread are observable that hidden investors speculative behavior. The majority of bitcoins owners are not able to capture the unbalances on the market venues also because there high risks can occur for those are not professional traders.

With the extent to capture the drivers behind these market inefficiencies a multiple regression model has been constructed, but firstly was necessary to create the database of the platforms active for the period considered. The data relative to the price and the daily volume were collected on the website bitcoincharts.com. The interest was primarily concentrated on the dependent variable under scrutiny, that is the price spread among the platforms, converted into dollars at daily exchange rates. It is used a benchmark currency exchange which is Bitstamp.net, that has been chosen because between those platforms that trade in dollars is the biggest in term on volumes. After an ANOVA test were selected the predictor variables, that are the daily transaction volumes, the variation in the exchange rate and the inflation rate. Hence, the first one is considered to be expression of the price movements because, on the basis of the amount of volume traded it is possible to predict the price trend. Being considered the FOREX arbitrage, the exchange rate variable is an essential element to study, to understand whether Bitcoin prices are affected by the appreciation or devaluation in the other currencies. Lastly the adoption of the inflation rate as predictor variable arose from the observation of high spread in countries affected by hyperinflation as the Latin American country, while this phenomenon is less sharp in the advanced countries with on the contrary deflationary spirals.

Other independent variables were object of study, transaction fees, security breaches and "AML" compliance, but after a first assessment those were considered not correlated to the spread and for this reason are not included in the regression model.

In the conclusive part will be explain how and in which measure those variables influence the spread.

Chapter 1

Money in the virtual world

1.1. Traditional theories of money

Money is a social institution[1], a tool that only has the value, which a society has given it. This tool was created to carry out transactions. Initially those transactions involved a physical *medium of exchange,* which served as a means to make the barter possible in the easiest manner. With barter any person possessing any surplus value, in terms of cattle or seeds for instance, could exchange it for something perceived to have a similar value but that generates satisfaction or utility for the part that lacks that good. In microeconomic theory the marginal rate of substitution shows the relative value that a good has for a person. Alongside the indifference curve are represented the demand patterns for individual consumers over commodity bundles. Of course the problem of this trade is directly linked to the "coincidence of wants" or complementary needs. The perishing of the products used in the barter transactions and the untrustworthiness of the trade parts led to the need of a third commodity into which trade wheat or other vanishing goods. The intermediate good assumed the

[1] ECB, Virtual schemes, October 2012.

function of *store of value,* overcoming the "coincidence of wants" costs and creating a trusteeship ecosystem, taking the roots of the commodity money. The emergence of intermediary commodities made the market more liquid because the actors were able to overcome the exchange incompatibilities triggering immediate transactions. Gold and silver were the mostly used metals for the scope aforementioned. The portability and transferability necessity conducted to the so-called commodity-backed money. Money consisted not any more in the intrinsic value of the commodity traded but in the underlying value that a certificate guaranteed. The certificate, generally a gold certificate, authenticated the exchange for a fixed quantity of the underlying commodity. The expansion of trade conducted to the creation of the bill of exchange, under which merchants and travelers could avoid the risk of travel with large amount of certificates and, at the same time, they were able to guarantee to creditors the payment at a specific time in the future. A third party that operated as financial intermediary guaranteed the convertibility of the certificate.

The modern concept of the commodity-baked money is held by the fiat money that, on the contrary, cannot be longer redeemed for commodity. The value of the fiat money is not related to its intrinsic or backed value, but it is tied with the trust in the legal tender, which create and control

money. Thus, money as also the function of unit *of account*[2], indeed, it determines the value of goods and services in standard numerical units. John Mynard Keynes in the "Treaties of money" explained that

"Fiat Money is Representative (or token) Money (i.e something the intrinsic value of the material substance of which is divorced from its monetary face value) - now generally made of paper except in the case of small denominations — which is created and issued by the State, but is not convertible by law into anything other than itself. and has no fixed value in terms of an objective standard"[3].

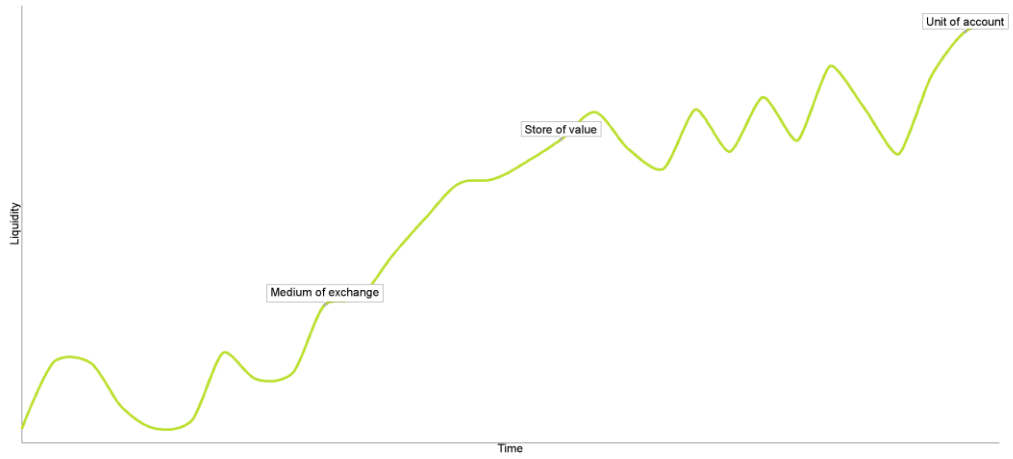
The element that makes money valuable for the social life is the trust in the central bank which issue such worthless tokens.

Events as the 2008 financial crisis can undermine that power. as a consequent people are led up to rethink the conventional economic and financial structures. For this reason it can be crucial for the established institutions to understand the "alternative" currencies that the contemporary world offers.

[2] Krugman P., Macroeconomics, 2012.

[3] John Maynard Keynes , "1. The Classification of Money". *A Treatise on Money*.p. 7, (1965) [1930].

Figure 1. : Functions of money from the Austrian perspective



Source: Šurda P., Economics of Bitcoin, 2012.

1.2. Virtual currencies creation and adoption

Money based on fiat currency has appeared to be an unreliable store of value. This phenomenon triggered the quest for alternatives that have been produced by the virtual community. A virtual community is to be understood as a place within cyberspace where individuals interact and follow mutual interests or goals[4]. Some of these communities have developed their own currency for exchanging goods and services. Virtual currency is defined by FinCEN, a United States department of Treasury, as "a medium of exchange that operates like a currency in some

[4] FinCEN's Mandate from Congress, U.S. Dep't of the Treasury, Financial Crimes Enforcement Network, 2013.

environments, but does not have all the attributes of real currency. It does not have legal tender status in any jurisdiction"[5]. Virtual currency includes credit card points, air miles, loyalty points, coupon and digital or cryptocurrency. The sharply use of this form of currency is determined firstly by marketing tools[6]. The marketers are interested in the exchange of personal data for digital content. For some authors as this trend increases as more digital currencies have the potential to compete with traditional currencies.[7]

This escalation can have positive effect for the consumers, contributing to the financial innovation and providing additional payment alternatives. On the other side these schemes pose some risks that can be connected to the lack of regulation by the side of the international institutions. (Table 1) The office of investor education and advocacy of the Securities and Exchange Commission (SEC) issued an investor alert to warn individual investors about fraudulent investment schemes that may involve virtual currencies[8]. The SEC is warned that the rising use of virtual currencies in

[5] FinCEN's Mandate from Congress, U.S. Dep't of the Treasury, Financial Crimes Enforcement Network, 2013.

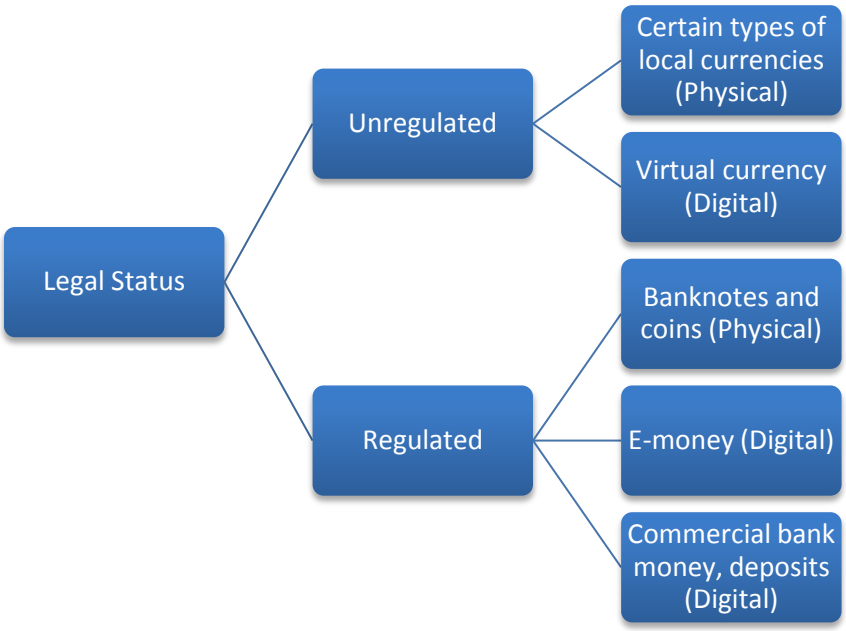
[6] Chowdury and Mendelson, Virtual currency and the financial system: the Bitcoin case study, 2013.

[7] *Ibidem.*

[8] SEC, Ponzi schemes using virtual currencies, 2013.

the global marketplace may entice fraudsters to lure investors into Ponzi and other schemes in which these currencies are used to facilitate fraudulent, or simply fabricated, investments or transactions.

Table 1: A money matrix



Source: European Central Bank. 2012

A Ponzi scheme is an investment scam that involves the payment of purported returns to existing investors from funds contributed by new investors. Ponzi scheme organizers often solicit new investors by promising to invest funds in opportunities claimed to generate high returns with little or no risk. In many Ponzi schemes, rather than engaging in any legitimate investment activity, the fraudulent actors focus on

attracting new money to make promised payments to earlier investors as well as to divert some of these "invested" funds for personal use[9].

Fraudsters can be attracted to use virtual currency also because that type of currency guarantees a higher degree of privacy than a conventional one. An example of criminal enterprise, which circumvents the law enforcement for the traffic of illegal goods, launder money, finance terrorism and evade tax is Silk Road. The site was launched in February 2011, the "Amazon.com of illegal drugs"[10] is accessible only through the anonymous internet browser The Onion Router (TOR), which operates in a way that online users are able to browse it anonymously and securely without potential traffic monitoring. It is held to be part of the deep web. To maintain the anonymity all the transactions made in this online market were issued by Bitcoin, the most controversial cryptocurrency present on internet. Even though the Silk Road server has been captured, the Bitcoin transactions and the suspect's wallet contained remain difficult for law enforcement to decrypt due to the tumbler used, delaying the

[9] *Ibidem*.

[10] NPR Staff, "Silk Road: Not Your Father's Amazon.com", 2011.

identification of buyers and sellers of illegal materials and liquidation of criminal proceeds[11].

With the extent to provide a certain regulation framework for virtual currency, the Senate Banking Committee of US prepared some recommendations, that are not in force yet, but that can forecast a future relevant legislation in this field. The greater parts of the concerns are related to how balance innovations and regulation. On one point the Committee is united, to apply the anti-money laundering (AML) regulation to these types of money: "A greatest supervision and examination of the virtual currency transactions can promote product innovation without sacrificing important protections for users, or, on the federal side, anti-money laundering or economic sanctions goal."[12]

Cryptocurrencies are well accepted by online merchants for the advantages that the use of this system can spawn. They can monetize new markets, lower transaction fees, get transactions instantly and avoid charge back[13]. The security of the system for both merchants and client is guaranteed by a protocol, known as a proof-of-work, which is a

[11] Dieb O, Bitcoin After Silk Road, 2013.

[12] Senate Banking Committee, Subcommittees on Economic Policy and national security and international trade and finance, Hearing on the present and future impact of virtual currency, 2013.

[13] Ahmad S., Nair M. and Varghese B., A survey on cryptocurrencies, 2013.

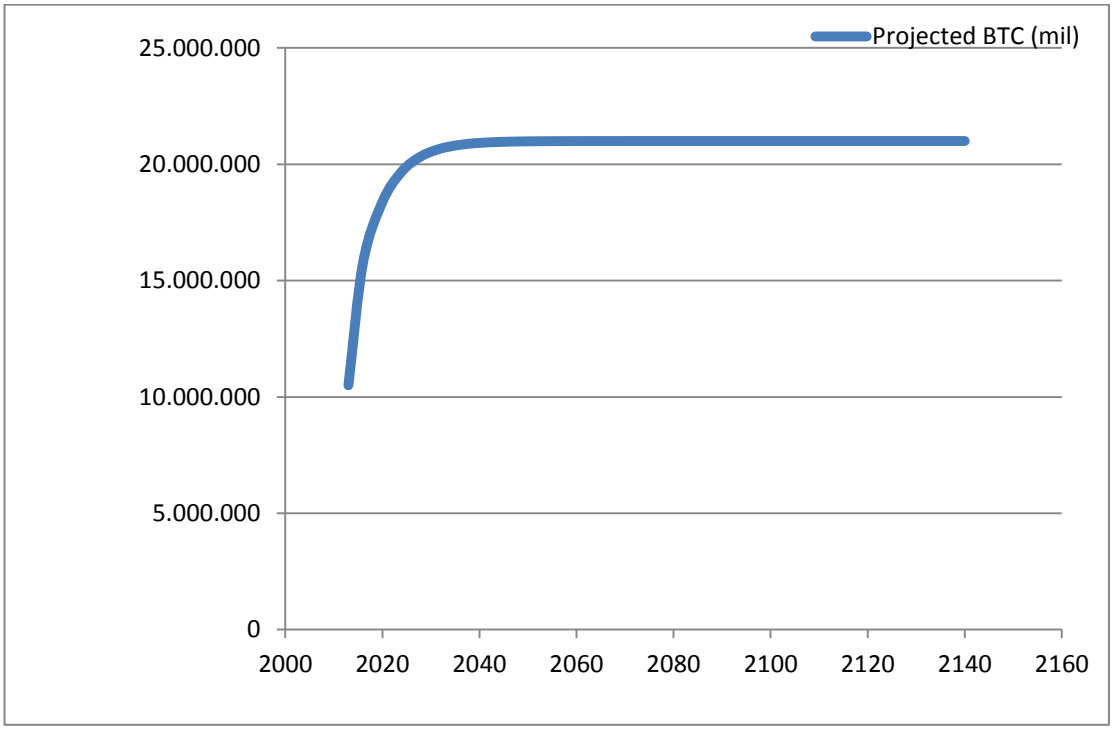
cryptographic analysis of the digital transactions. Using that system it is possible to bypass the need to trust in third party, therefore the overhead costs are lower and the digital product are delivered instantly for digital coins in return. A decentralized network, the third party in this world, of peer-to-peer computer nodes works in sync to create and manage the currency. Therefore, it is clear that the main advantage for merchants to use a cryptocurrency is related to the easiness of starting up an account and to the acceptance time of the payments. In the client point of view an advantage are the lower fees of this method of payment compare to the credit cards transaction costs but also the ability to purchase goods and services across borders within minutes.

1.3.Differences between fiat currency and virtual currency

The main difference between virtual currency and real money is that the former is based on a fully decentralized monetary system, no group or individual may accelerate, stunt or in any other way significantly upset the supply of money. The cryptocurrency community knows prior the final amount of virtual currency in circulation at a specific time in the future. It is allowed to create, through the mining process, only a specific quantity of money that grows at a more than proportional path until a

specific time period, after that the quantity of money in circulation will be stable.

Chart 1: Bitcoin supply to taper to 21m by 2140



Source: BofA Merrill Lynch Global Research

In centralized economic systems such as the Central Banks system, governments regulate the value of currency by simply printing units of fiat money or demanding additional reserves to the national banks. Notwithstanding governments cannot produce units of cryptocurrency. The pioneer system in the virtual world which created the basis of the alternative currency was developed by an anonymous group of individual

known as Satoshi Nakamoto that explains in his paper why the system was started up: "What is needed is an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party. Transactions that are computationally impractical to reverse would protect sellers from fraud, and routine escrow mechanisms could easily be implemented to protect buyers."[14] While the Bitcoin protocol was getting off the ground, hundreds of virtual coins have been created, up to now fourteen are regularly active.[15]

The system is regulated by the network of users, instead of a government authority, but them shouldn't trust in the community member due to give a value to the currency, as happens when there is a issuer of token banknotes. Indeed the system is based on cryptographic proof, which gives to the holders the guarantee of the transaction value. Most cryptocurrencies are designed to gradually introduce new units of currency, placing an ultimate cap on the total amount of currency that will ever be in circulation. This is done both to emulate the scarcity (and value) of precious metals and to avoid hyperinflation. As a result, such cryptocurrencies tend to experience hyperdeflation as they grow in

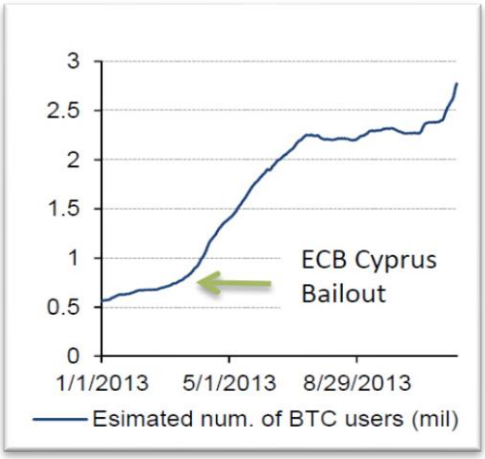
[14] Nakamoto S., Bitcoin: A Peer-to-Peer Electronic Cash System, 2009.

[15] Wikipedia, list of cryptocurrencies, 2014.

popularity and the amount of the currency in circulation approaches this finite cap.[16]

Another distinguish element compared with fiat money is the anonymity. The owner of a digital currency can use a pseudonymous to create a digital wallet into which holds its portfolio. The authorities couldn't control the capital flow or eventually confiscate the deposit. Such point of difference is especially appreciates by the citizens of crisis countries.

Chart 2: BTC user base has grown 5- fold YTD



Source: BofA Merrill Lynch Global Research

During the financial crisis the interest in cryptos sharply increases, insomuch as the literature find the turning point in the adoption of the protocol when Cypriot authorities, as part of their European assistance

[16] Ahmad S., Nair M. and Varghese B., A survey on cryptocurrencies, p.5, 2013.

package, were prepared to implement a private sector haircut of deposits.[17](Chart 2)

1.4.Virtual currency schemes and types

It is possible to provide a more specific definition of virtual currency as the follow: " A virtual currency is a type of unregulated, digital money, which is issued and usually controlled by its developers or users and accepted among the members of a specific virtual community".[18]

There are typically two ways to obtain virtual currencies. In many virtual currency schemes, the fastest way is to purchase it using real money at a conversion that has been previously established. Accordingly virtual currency itself usually has no commodity-backed value. Secondly, users can often increase their stock by engaging in specific activities, for instance by responding to a promotion or advertisement or by completing an online survey. To identify the virtual currencies the European Central Bank issued on October 2012 a report[19] in which classifies the different cryptocurrencies based on the relation of the latter to the real economy,

[17] Woo D., Gordon I. and Iaralov V., Cause and Effect: Bitcoin a first assessment, Bank of America Merrill Lynch, FX and rates global, 2013.

[18] ECB, Virtual currency schemes, 2012.

[19] *Ibidem.*

the classification was firstly issued by Guo and Chow.[20] In the report three types of currencies are distinguished. A closed virtual currency schemes, a virtual currency schemes with unidirectional flow and a virtual currency schemes with bidirectional flow.

In respects to the first one, no link to the real economy are shown, an example of this currency is the one used in the online games. For that reason it is also called "in-game only" scheme. The holders cannot exchange the game currency into a real currency, in this way the separation to the real economy is well defined. Guo and Chow provide a form of exchange for it but on a volunteer basis. for this reason the ECB does not account of it.

Regarding the virtual currency scheme with unidirectional flow, in this case there is a one-way relation to the real world, because to purchase the virtual currency the user need to exchange a real currency at a specific exchange rate, but he cannot exchanges back to the original currency. The problem for the holders of this type of scheme is that it cannot be compensated if the owner has a surplus of it. Another issue can be the exchange rate at which purchase the virtual currency, in fact, the scheme

[20] Guo J. and Chow A., Virtual money systems: a phenomenal analysis, IEE CEC'08, p.267-272, 2008.

owner decides the rate. To this type are associated the Facebook credits, the Nintendo points or the airlines' frequent-flyer programs.

Probably the most important scheme, for the strong link that it had with the real economy is the third one: the virtual currency scheme with bidirectional flow. It is defined as the users possibility to buy or sell virtual money according to the exchange rates with their currency. "The virtual currency is similar to any other convertible currency with regard to its interoperability with the real world. These schemes allow for the purchase of both virtual and real goods and services."[21] Some authors metaphorically explains how this typology of currency can be compared to the casino' chips, the virtual currencies are purchased to play in the building and then they are exchanged at the end of the night[22]. Bitcoin, Litecoin, Dogcoin or Altcoins are the mostly used currency of the third type. The difference between these currencies is basically the algorithm created for their use. For example Bitcoin is based on the SHA-256 algorithm while Litecoin makes use of the Scrypt encryption algorithm, as opposed to SHA-256.

[21] ECB, Virtual currency schemes, 2012.

[22] Bogliolo A., Giglietto F., Polidori P. and Stradini F., Il valore reale del denaro virtuale, March 2012.

Virtual currency schemes can be considered to be a specific type of electronic money, basically used for transactions in the online world. However, a clear distinction should be made between virtual currency schemes and electronic money. According to the Electronic Money Directive (2009/110/EC)[23], "electronic money" has monetary value as represented by a claim on the issuer, which is stored electronically, issued on receipt of funds of an amount not less in value than the monetary value issued and accepted as a means of payment by undertakings other than the issuer. Although some of these criteria are also met by virtual currencies, there is one important difference.

In electronic money schemes[24] the link between the electronic money and the traditional money format is preserved and has a legal foundation, as the stored funds are expressed in the same unit of account (e.g. US dollars. euro. etc.). In virtual currency schemes the unit of account is changed into a virtual one (e.g. Linden Dollars. Bitcoins). This is not a minor issue, specifically in type three schemes. Firstly, these schemes rely on a specific exchange rate that may fluctuate, since the value of the virtual currency is usually based on its own demand and supply. Secondly, to some extent the conversion blurs the link to traditional currency, which might be

[23] Official journal of the European Union, Directive 2009/110/EC of the European Parliament and of the council, 16 September 2009.

[24] CGAP, Bitcoin Versus Electronic Money, January 2014.

problematic when retrieving funds, if this is even permitted. Lastly, the fact that the currency is denominated differently (i.e. not in euro, US dollar, etc.) and that the funds do not need to be redeemed at par value means that complete control of the virtual currency is left to its issuer, which is usually a non-financial company. Moreover, electronic money schemes are regulated and electronic money institutions that issue means of payment in the form of electronic money are subject to prudential supervisory requirements. This is not the case for virtual currency schemes. Consequently, the risks faced by each type of money are different. Electronic money is primarily subject to the operational risk associated with potential disruptions of the system on which the electronic money is stored. Virtual currencies are not only affected by credit, liquidity and operational risk without any kind of underlying legal framework, but are also subject to legal uncertainty and fraud risk, as a result of their lack of regulation and public oversight.

There are several reasons for a virtual community to issue its own virtual currency. By implementing a virtual currency scheme focused on the online world (basically for virtual goods and services) a company can generate additional revenue. The use of virtual currencies can motivate users by simplifying transactions and by preventing them from enter their personal payment details every time they want to make a purchase. It can

also help lock users in if, for instance, it is possible to earn virtual money by logging in periodically. If users are asked to fill out a survey or to answer other questions in order to earn extra virtual money, users reveal their preferences, thereby providing valuable information for commercial use. Virtual currencies can also be used as an important tool for application developers and advertisers when designing a strategy to reap the benefits of the virtual goods market. The virtual community is particularly concentrated in Asia and the United States.

The first cryptocurrency to emerge was Bitcoin (BTC), based on the SHA-256 algorithm[25]. This virtual commodity was conceptualized in a whitepaper written in 2009 by a pseudonymous author who went by the name Satoshi Nakamoto. Over the course Bitcoin's first four years, the market price of a single Bitcoin has fluctuated from below $0.01USD to over $250USD. The highly volatile price has made Bitcoin an attractive investment alternative for traders seeking to profit from market speculation, while at the same time the market volatility has made long-term investors and daily users hesitant to participate for long periods of time. A single Bitcoin can be spent in fractional increments that can be as small as 0.00000001 BTC per transaction. The smallest increment of a

[25] SHA-256 (secure hash algorithm, FIPS 182-2) is a cryptographic hash function with digest length of 256 bits. It is a keyless hash function; that is, an MDC (Manipulation Detection Code).

Bitcoin is known as a Satoshi, named after the original whitepaper author. The protocol allows for incremental transactions in the event the value of BTC rises to the point where micro transactions will become commonplace. The rise in the value of BTC is anticipated because there is a limit to the total amount of Bitcoin will ever be created. Once the Bitcoin blockchain is completed, users can only circulate the coin that still exists on the network. As time goes on, Bitcoin will be lost and destroyed through daily use. The principles of supply and demand will come into play, increasing value of remaining Bitcoin. Bitcoin is currently the most reputable of all cryptocurrencies, as it is the oldest, and has been the subject of mainstream media coverage due to rapid market fluctuations and an innovative technical concept. Bitcoin can be interpreted as being the 'gold standard' of cryptocurrency because all alternative cryptocurrency market prices are matched to the price of BTC.

Another emerging virtual currency is Litecoin[26] (LTC) that can be considered the 'silver standard' of cryptocurrency, as it has been the second most adopted cryptocurrency by both miners and exchanges.

[26] Ahamad S., Nair M. and Varghese B., A Survey on Crypto Currencies, Proc. of Int. Conf. on Advances in Computer Science, AETACS (Association of Computer Electronics and Electrical Engineers), 2013.

Litecoin makes use of the Scrypt encryption algorithm[27]. One of the goals of Litecoin was to have transactions confirm at a faster speed than of the Bitcoin network, as well as make use of an algorithm that was resistant to accelerated hardware mining technologies such as ASIC. The Scrypt algorithm is resistant to ASIC mining due to intense RAM requirements. The total amount of Litecoin that is available for mining and circulation is four times the amount of Bitcoin, meaning there will be quadruple the amount of Litecoin available to Bitcoin.

Dozens of project forks emerged within the cryptocurrency software development community. In slang these forks are known as Altcoins[28], 'forks' of either Bitcoin or Litecoin, meaning they use both SHA-256 and Scrypt encryption algorithms and feature their own unique properties. Names of various Altcoins range from memorable to comical. Feathercoin, Terracoin, P2PCoin, BitBar, ChinaCoin, BBQCoin. The profitability of mining and trading Altcoin varies on a daily basis. Some Altcoins exceeds the profitability of Bitcoin at times, while others are less profitable. It is

[27] In cryptography, scrypt is a password-based key derivation function created by Colin Percival, originally for the Tarsnap online backup service. The algorithm was specifically designed to make it costly to perform large-scale custom hardware attacks by requiring large amounts of memory. In 2012, the scrypt algorithm was published by IETF as an Internet Draft, intended to become an informational RFC, which has since expired. A simplified version of scrypt is used as a proof-of-work scheme first implemented by Litecoin.

[28] Pleines M, Bitcoin-Alternativen: Altcoins, Epubli, 2013.

believed by some crypto-economists that Altcoins contribute to a diverse crypto-commodities marketplace, which is a good thing as there is more opportunity for speculative arbitrage and mining difficulty levels are spread over many different networks. Other crypto-economists disagree about the beneficial aspects of Altcoins; citing overuse of the cryptocoin concept will dilute widespread adoption and restrict the use of the technology to speculative trade markets instead of daily commerce.. Finally is useful to describe the mining cryptocurrencies. The term 'mining' is slang for the use of computational power to process transactions for a cryptocurrency blockchain in order to receive a reward of cryptocurrency for the effort. The computational power will come in the form of CPU processing or GPU processing. Miners are rewarded for successful 'shares.' or completed computations, by receiving a payment with fees that are collected along the way by the peer-to-peer network. The reward for a successfully completed Bitcoin block is 25 BTC and 50 LTC for a Litecoin block, and diminishes as the blockchain grows. The computational power requirements differ depending on the encryption algorithm being used. SHA-256 mining rates are measured in GH/s. whereas Scrypt mining rates are measured in KH/s. While the cryptocurrency transaction from one account holder to another is very smooth, fast and efficient, the exchange between fiat currency to crypto

currency has proven difficult for the masses and has kept many merchants, customers, traders and investors from joining this new revolutionary way to transfer funds across the globe with a quick and easy click of the mouse. There are a few ways one is able to obtain crypto currencies. By mining it, which simply put without getting too technical means that any CPU (Central Processing Unit), a GPU (Graphic Processing Unit) or the more advanced ASIC (Application Specific Integrated Circuit) can be used to connect to the crypto currency network and participate in the verification and confirmation process of a crypto currency transaction. By doing so, the transfer fees and newly minted currency are bundled and automatically transferred to the application that was able to provide a solution to a specific block of transactions. The same way the Visa network approves charges, the crypto currency network helps approve transactions. Since the network has expanded exponentially over the past year, mining has become less profitable for the average miner. Mining new blocks result in an average of more than $400.000 in new currency created every day, which help incentives miners to continue supporting the network.

Another way to obtain these types of currencies is by selling goods and services for crypto currencies. Many merchants are choosing to accept

crypto currencies in return for selling goods and services. The easiest and most popular way is by exchanging fiat currency to crypto currencies.

1.5.Legal framework

The development of a global electronic commerce, the currently financial crisis and the lack of trust in government institutions pose the basis of the born of internet-based money stored on a computer and transferred over the World Wide Web. This type of money is conceptually free to flow across borders without the application of a single regulation. Some authors[29] underline the necessity of an international regulation of this phenomenon in order to avoid foreign currency exchange instability. The institutional body that has the power to control these mechanisms is the International Monetary Fund. Nonetheless the IMF's rules apply only to nations that have agreed to them. But all the cryptocurrencies issued are not backed to a single country, thus these are not bound by the IMF's guidelines. Another issue for the IMF is related to the ability of the Fund to prevent or at least dump a speculative attack down. "A speculative attack occurs when an investor wishes to take advantage of a currency that has depreciated in value relative to other currencies. If left unchecked.

[29] Plassaras N., Regulating digital currencies: bringing bitcoin within the reach of IMF, Chicago Journal of International Law, volume 14, No. 1, pp. 377-407, 2013.

a successful attack can push a weak currency's value even lower, resulting in a destabilization of the international foreign currency exchange."[30] To better explain this threat suppose that the speculator takes a short position in the weak currency. To take it he has to borrow a sum of the currency against which speculates, then he will sell it for a more valuable currency with the intention to buy the devaluated currency back at an even lower value. The profit is generated by the difference in value of the less valuable currency between the momentum of selling and buying. The speculator triggers the value of that currency down to buy it back at a lower price. The profits are made at the expense of banks generally. In fact speculators, for locking their positions, enter long-dated forward contract. Once the weak currency continues to depreciate in value the bank cannot do anything until the contract matures. At that time "maturity mismatch" brings profits to speculators. In order to be responsive Central Bank absorb the "maturity mismatch" of the commercial banks buying commercial bank's excess of the weak currency in exchange for stronger currency at the exchange rate.[31] On the other side, the Central Bank that

[30] Matsui A., Strong currency and weak currency, 12 Journal of Japanese and international economies, pp.306-307, 1998.

[31] Tijmen R.D., Jager H. and Klassen F., Defending against speculative attacks, 7th Bundesbank Spring Conference on Economic Risk, Discussion paper N. 2009-011, February 2009.

has not have enough reserves of the currency needed can turn to the IMF for assistance.

The IMF to counter effectively a speculative attack has to acquire a supply of cryptocurrency to input in the market if necessary. At this stage is fundamental to beat the clock avoiding the escalation in value of this money that would produce an excessive expenditure for the counteracting of the Fund. The International Monetary Fund has changed its role deeply since it was created. This ability to be active and flexible to the economic challenges should be proven also in the present day.

This body was created to overcome the collective action problem of allowing individual countries to enact self-interested economic policies without jeopardizing the global economy.[32] The first goal was to promote a stable international economy through the regulation of the foreign currency exchange. In order to perform the role was initially adopted the gold standard, under which the value of each national currency was fixed in relation to the price of gold. This system was in part replicated in 1945. with the creation of the Bretton Woods System. At the time, due to avoid post conflict currency war, the IMF coordinated a fixed parity system. The currency of the nations that were in compliance with the Articles of

[32] Plassaras N., Regulating digital currencies: bringing bitcoin within the reach of IMF, Chicago Journal of International Law, volume 14, No. 1, pp. 377-407, 2013.

Agreement were determined in value of the US dollars, which was in turn determined by the price of a set amount of gold ($35/ounce). The exposition of the United States was such as in 1971 the Nixon government decided to collapse the system, devaluating the dollar by more than 10% (threshold adopted in the system). Today the role of the Fund is more marked to regulate international economic transactions and to prevent international instabilities caused by both monetary and financial crisis.

If the value and usage of virtual currency will continue to rise it poses a threat to the stability of foreign exchange market. Especially because nor the national central banks neither the IMF have the ability to offer digital currency as part of their currency reserves.

Regarding the single countries regulation, the legacy of cryptocurrencies is under evaluation. In US, for instance, on 18 November 2013 the United States Senate held a committee hearing titled *Beyond Silk Road: Potential Risks. Threats and Promises of Virtual Currencies*[33] to discuss virtual currencies. At this hearing, held by senator Tom Carper. Bitcoin and other currencies were considered in a positive way, stated that Bitcoin as other virtual currencies were a "legal means of exchange" and that "online payment systems, both centralized and decentralized, offer legitimate

[33]U.S. Senate Committee On Homeland Security And Governmental Affairs, One Hundred Thirteenth Congress, First Session, Beyond Silk Road: Potential Risks, Threats And Promises Of Virtual Currencies, November 2013.

financial services" by US officials. Notwithstanding some concerns, for the escalation of illegal virtual crimes that have been committed using these types of currencies arose. A turning point, more for the definition of this system rather than for legal purposes, was the position of the Internal Revenue Service of the US Government Accountability Office. It declared in March 2014 that opted to consider Bitcoin. or other similar schemes, as a form of "property rather than a currency, meaning that every transaction where Bitcoin is used as payment would be subjected to capital gains tax. The IRS also announced that Bitcoin mining activity would be taxed as income on the basis of fair market value as of the date of the specific activity, and that all of the foregoing guidance would be applied retroactively."[34]

In March 2013. FinCEN issued an advisory that their rules for combating money laundering and terrorist financing, as well as the state-by-state licensing as money transmitters apply to virtual currency businesses, which must collect and report relevant data.

[34] Internal Revenue Service, Notice n.2014-21, IRS Virtual Currency Guidance: Virtual Currency Is Treated as Property for U.S. Federal Tax Purposes, General Rules for Property Transactions Apply, March 2014.

Chapter 2

The Bitcoin: a case study

2.1. What is Bitcoin?

Bitcoin firstly appeared in a whitepaper by an unknown computer scientist using the pseudonym Satoshi Nakamoto on January 2009[35]. In the paper the inventor explained the system operation that permits the creation of this virtual currency.

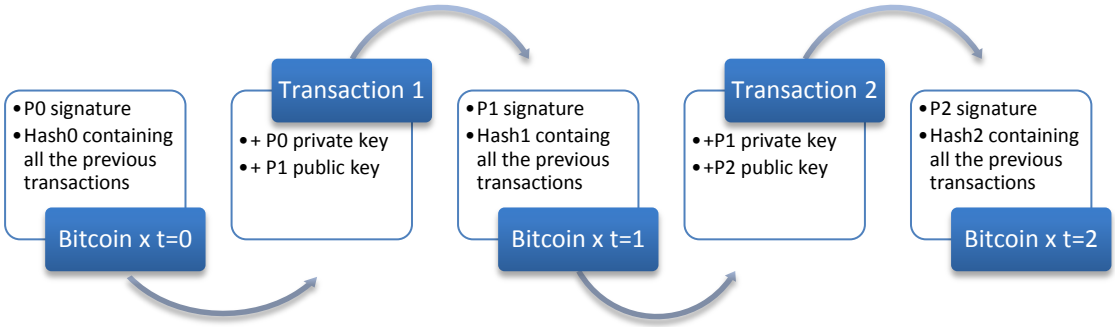
Bitcoin with a capitol "B" is a peer-to-peer decentralized network where it is not required a central clearing house or financial institution clearing the transactions. The unit of that network is bitcoin with a little "b" and it serves as a medium of exchange for the transactions made by the network users. The security of the system, considering the absence of a central institution, is coordinated by the miners. Miners gather new transactions into blocks and those blocks are attached to the end of the Blockchain. (Graph 1)

Therefore Bitcoin consists of two components. The first one is a ledger, the so-called Blockchain. All Bitcoin transactions are publically available

[35] Nakamoto S., Bitcoin: A Peer-to-Peer Electronic Cash System, 2009.

and every computer connected to the system, also known as node, has a copy of these transactions, in order to prevent fraud. Each transaction that has cleared by the nodes is pooled into a block. The sequence of the block is the ledger or Blockchain.[36]

Graph 1: Bitcoin Transactions



Source: ECB

The blockchain has the function to record all the transactions transparently and to prevent the double spending problem. Indeed suppose that Bob sends Alice 5$, there is no risk that the same amount can be send to someone else because when he transferred his ownership the track of the deal is recorded in the block chain. This

[36] Šurda P., Economics of Bitcoin: is Bitcoin an alternative to fiat currency and gold?, WU Vienna University of Economics and Business, November 2012.

mechanism is already used by credit cards companies and banks but at a cost; it is estimated that the use of Bitcoin over traditional payments can save over 100 billion dollars per annum.[37](Table 1)

Table 1: Potential annual net savings with Bitcoin based on 2013 volumes

2013 Market size ($bn)	Retail	E-commerce	Remittances
Dollar volume by market	10.383	609	549
Prevailing average pricing	2.5%	2.9%	8.9%
Bitcoin pricing	1%	1%	1%
Prevailing transaction fees	259.6	17.8	48.9
Bitcoin transaction fees	103.8	6.1	5.5
Potential saving with Bitcoin ($bn)	155.7	11.8	43.4

Source: Goldman Sachs Global Investment Research

In the table it is shown the annual net savings if all electronic payments were conducted in Bitcoin. Considering the data, the hypothetical savings for the retail point of sale could be over $150 billion and for the e-commerce almost $12 billion in fees per annum based on global 2013 purchase volume.

The second component is the keypairs. There are two keys one public and one private. The public key has the function of identify a Bitcoin

[37] Goldman Sachs, All about Bitcoin, Global Macro Research, March 2014.

address, like an account number in a bank, while the private key is known only by the owner of Bitcoin, who will use it to process the transactions. [38]

Miners supervise all this mechanism solving computational problems to create new blocks and in this way they issue new virtual currency.

There are some strict rules regarding this process. Each block can create only a certain amount of the digital currency, due to prevent hyperinflation caused by unbalances between supply and demand. Furthermore to maintain the predetermined level plausible (21 million of Bitcoins in circulation in 2140), the "proof of work" mechanism controls the duration of the blocks creation, in a way that every 10 minutes a new block is created.

Otherwise it is possible to constrain the increase in the Bitcoin's money supply enhancing the degree of difficulty of the computational task for the creation of each block. (Chart 1)

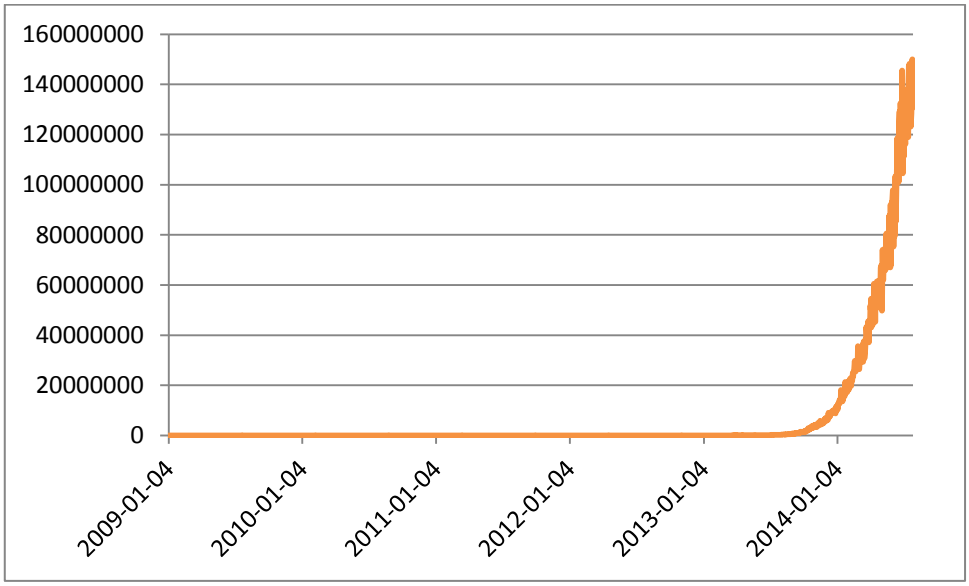
Miners that solve the mathematical calculations and subsequently validate a block transaction are awarded with 25 bitcoins[39]. Therefore

[38] *Ibidem.*

[39] CGAP, Bitcoin versus electronic money, January 2014.

new currency is issued in the network, but every four years this reward is halved to constrain the number of Bitcoins in circulation[40].

Chart 1: Bitcoin Hash Rate[41] (in GH/s)



Data Source: www.blockchain.info

An analogy used to explain this complicated mechanism is the follow: "suppose competing journalists (**miners**) are asked to document the national news on each given day for the National Archives. The journalist is asked to write down the events (**transactions**) in a book (**block**) and the archive will eventually buy one such book for a fixed fee.

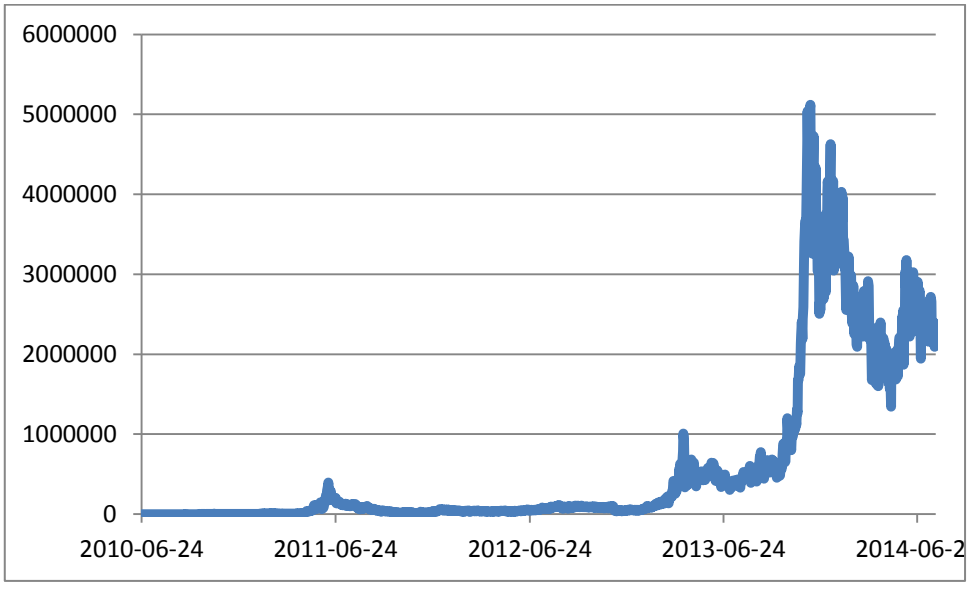
[40] Kostakis V. and Giotitsas C., The political economy of Bitcoin, Triple 12(2), pp. 431-440, 2014.

[41] The estimated number of giga hashes per second (billions of hashes per second) the bitcoin network is performing.. The hash rate is the measuring unit of the processing power of the Bitcoin network. The Bitcoin network must make intensive mathematical operations for security purposes. When the network reached a hash rate of 10 Th/s. it meant it could make 10 trillion calculations per second.

To determine which of the books the archive will buy, the archive has an additional requirement for journalists that the book contains the fingerprints of 10 people whose birthday was on that particular day. Note that the list of people isn't related to the national news (**transactions**) but is simply meant to control the supply of books coming out per day. As more journalists collaborate to find people. the archive increases the number of fingerprints required."[42](Chart 2)

Whereas through exchanging Bitcoin for other currencies the transaction involved money that has been created yet. As described in chapter one, another easiest method to acquire Bitcoin is exchanging fiat currency for Bitcoin.

Chart 2: Bitcoin Miners Revenues (in BTC)



Data Source: www.quandl.com

[42] BofA Merrill Lynch. Bitcoin: a first assessment. December 2013.

The investor has to register in an exchange platform where he will create his own wallet of bitcoins previously exchanged from his bank account. This operation involved some risks.

Firstly he bears a credit risk because he has to transfer bitcoins from a personal account to a third party's account where he will deposit the money exchanged. But this risk is similar to entrust in a depositary institution. Then there is the operational risk, because sometimes hackers target these platforms, so for the account's owner could become impossible to access to its wallet. There are several vulnerable points in the Bitcoin system in term of security and the majority of them are related to the system flaw's of the exchange platforms. One of the causes that led to the downfall of Mt. Gox was the "malleability issues". The protocol of one of the biggest exchange platform until February 7 2014 was many times threaten by fraudulent users. The fraud was perpetuated by the exchange clients, that said, that they have never received the money exchanged. The exchange had to find the transaction using the Bitcoin hash but in the meanwhile the transaction was changed by the client due to receive the money again. After the scandal the Bitcoin Foundation fixed the protocol to run the system properly by both exchanges and customers.

2.2 Advantages and Disadvantages

The main drivers that have contributed to the Bitcoin acceptance by the virtual community are linked to its peculiar system. Therefore the decentralized network that verifies and controls the Bitcoin transactions is characterized by the absence of government institutions. This element has been seen by the libertarians' supporters as the feature of the cryptocurrency. Especially in the contemporary market where the austerity measurements have affected directly the people trust in the global and local governments. But the design of the protocol also led to another direct effect that is the removal of middleman for the trade but not the exchange of bitcoins[43]. Considering the possibility for immigrant workers, almost the 3% of the entire world population[44]. to send remittances back home without pay supplement fees, generally very high being in the market only few and big providers (Western Union. MoneyGram and Euronet). Furthermore the elimination of third parties contributes to save time during the trading process, in this way consumers would prefer to use this system to send capital across the world in few

[43] Moore T. and Christin N., Beware of the middleman: Empirical analysis of the Bitcoin exchange risks, Financial Cryptography and Data Security, Lecture Notes in Computer Science Volume 7859, pp. 25-33, 2013.

[44] World Bank, Migration and Remittances, 2nd edition, 2011.

minutes rather than wait the banks processing time. This point of strength is feasible due to the unnecessary exchange of currencies usually required for operation in different countries. Nevertheless some authors stated that middleman are present in the system when exchange platforms are involved in bitcoin acquisition. In fact when a user convert its currency into BTC he will use a third party who exchange and eventually storage his windfall. Moore and Christin (2013) examined the track record of 40 Bitcoin exchanges established in the past three years to assess the risks related to those platforms. The result of their study found that

"an exchange's transaction volume indicates whether or not it is likely to close. Less popular exchanges are more likely to be shut than popular ones….[While] popular exchanges are more likely to suffer a security breach."[45]

Accordingly not all the bitcoin transactions are covered by the advantages of the decentralized system. An additional critic regards the confirmation time of the transaction that has to be recorded in the ledger or blockchain.

[45] Moore T. and Christin N., Beware of the middleman: Empirical analysis of the Bitcoin exchange risks, Financial Cryptography and Data Security, Lecture Notes in Computer Science Volume 7859, pp. 25-33, 2013.

The delayed transaction confirmation[46] depends on the time to generate new block. Each block is generated about every 10 minutes, that is also the confirmation period for the transaction. This can be problematic because after a single confirmation it is possible to double spend the transaction and the blockchain is forked. To protect against double spending the technology was implemented, but even more time for transaction confirmation is needed now. Fifty minutes is the time needed to add additional blocks to the chain, this period is however always less than the time needed by international money transfer providers. The direct effect of the delay confirmation is the illiquidity of the market. Till the market remain illiquid, more will be difficult for Bitcoin to become a significant international currency.

Albeit user who decide to invest in bitcoin for financial purposes incur in very low fees in general around the 1%.

Another advantage of the bitcoin usage for the transaction is that the client can perform the deal anytime anywhere. That also means that there are not cost of transportation, storage and security[47]. Those form of

[46] Barber S., Boyen X., Shi E. and Uzun E., Bitter to Better- How to make Bitcoin a better currency, Financial Cryptography and Data Security, 16th International Conference, Kralendijk, Bonaire, pp. 399-414, February-March 2012.

[47] Rogojanu A. and Badea L., The issue of competing currencies. Case study-Bitcoin, Theoretical and Applied Economics, Volume XXI, No. 1(590), pp.103-114, 2014.

business flexibility are considered a save of cost and time. In USA, for instance, every year are spent 60 billion dollars for issuance expenditures[48].

Still related to the peculiarity of the protocol another strength of the scheme is the anonymity. When the owner of the virtual currency send somebody money, the operation is publicly verifiable in the blockchain, hence during this process no payment credentials are needed. Likewise to start up a wallet containing the currency it is not necessary to register the details of the holder, who can use a pseudonymous to process the transactions. The anonymity factor was considered by Bitcoin skeptics as the central weakness of the entire scheme and also the reason why this technology will never hit the roof. In their standpoint people who are willing to hold transaction in anonymity are those involved in illegal activities, and the presence of this shadow around the Bitcoin network deters the widely acceptance of the digital currency. This is why the American Treasury announced that in the case of the digital currency it will apply the rules concerning money laundering.

The virtual community attracts many people that are willing to find an alternative to cash. Bitcoin offers to them a substitute in terms of security,

[48] Plassaras N., Regulating digital currencies: bringing bitcoin within the reach of IMF, Chicago Journal of International Law, volume 14, No. 1, pp. 377-407, 2013.

transparency of transactions and counterfeiting. Since the currency is in digital format there are some returns in using it rather than cash. Firstly it is easier to carry than cash and it can be a strengthens especially in economies with large scale transactions. Secondly thanks to the innovation generated by the scheme developers bitcoins are easier to track than cash; that is workable because each "coin" contains an electronic record of each transaction that coin has gone through since it was created. The automatic verification makes also impossible to counterfeit. In effect when bitcoins are sent there are not physical money in circulation but rather it is the network that submits the transaction verifying the validity of the public address of both the sender and the receiver.

An advantage in the merchants perspective, that is at the same time a drawback for consumers, is the not reversibility of the transactions. So once a transaction is recorded in the blockchain it is impossible for the user to receive the money back in case of mistake. Moreover if the wallet is accidentally lost there is not an assurance which permits to reconstruct the deposit.

In an economic perspective the finite supply of bitcoin can be seen as an advantage in fighting against inflation. This element was introduced by the developers to emulate the supply of gold and to protect the currency value against governments and central banks instrumentality.

Furthermore it could be attractive for those looking to hedge their position against unstable local currencies.

On the other side the capped supply can generate a deflationary spiral. In the fiat currency system central banks increase the supply of money in circulation to accommodate the economic growth, while in the Bitcoin system it is not possible, so if the transactions in bitcoin will continue to rise then there is no alternative except for an appreciation of its value. Furthermore some authors view in the Bitcoin system design the basis of the quantity theory of money, for which if more units of a currency are issued, then the value of each unit should fall[49]. At this attempt Bitcoin predefined cap should make prices of good measured in bitcoin stable. But as said before one problem is that if a currency had a constant value, then the prices in terms of this currency would be falling. The stability in the market is not generated by unmoving the components but equilibrating them.

The money supply cap has seen as the intrinsic strength of the currency, but it is also its greatest weakness.

The most controversial feature is the price volatility. Indeed it can compromise the use of Bitcoin as store of value and so also its future usage

[49] Younan S., Bitcoin: Gold and The Quantity of Money, The Gold Standard,issue 37, January 2014.

as money. The high volatility is linked to the value of bitcoin as more people become aware of it. Another consideration could be that the speculative nature of the market produces unstable returns. In addition it can compromise the use of Bitcoin as medium of exchange, because for merchants would be unprofitable to accept payment in a currency that the day after has dropt by 10% in value.(Chart 3)

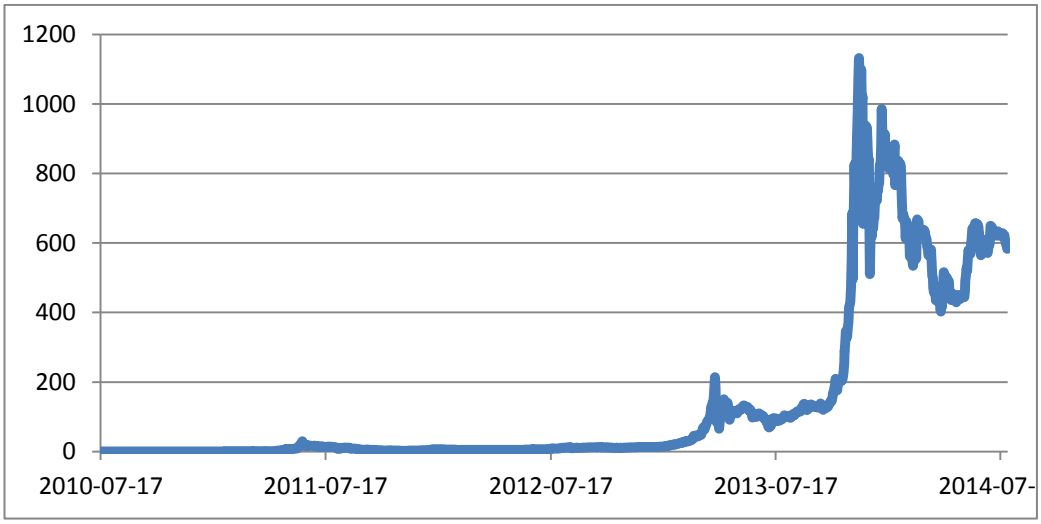
Likewise the absence of a derivative market make impossible for investor to hedge their position against price volatility. Although there is one large benefits for investors that is the negative correlation that Bitcoin has with risk sensitive assets.[50]

As aforementioned the speculative attacks affect the bitcoin realized volatility, but the negative effect that these could produce are even larger because the international body which should oversee potential global unbalances, the IMF, has not the power to intervene in cryptocurrencies' speculation, because is not clear the legislative framework concerning this area.

Besides a strong point in the Bitcoin ecosystem is properly the lack of regulation, but at the same time new regulation would produce higher transaction cost and thus limit the use as medium of exchange.

[50] BofA Merrill Lynch, Bitcoin: a first assessment, December 2013.

Chart 3: USD/BTC Weighted Price[51]



Data Source: www.quandl.com

Another problematic issue is connected to the fact that Bitcoin is not a legal tender, the effect of it is the lack of legal duty to accept the digital coins. Moreover it can be a dramatic matter for its potential in the OTC market.

2.3. Uses of Bitcoin: Medium of exchange and store of wealth

The popularity of this virtual currency is related to its exploitable value as a medium of exchange. Considering that, nowadays, the e-commerce sector is sharply increasing, the necessity for a rapid and easy method of payment is heightening too. But also the globalization spreads the

[51] Aggregated bitcon price index from multiple exchanges providing a weighted average bitcoin price.

requirement for a new money transfer provider, which can compete to the traditional ones. The medium of exchange has the function to bypass the problem of "coincidence of wants" and in this term a currency to be effective has to be liquid and widely accepted.[52] Even though Bitcoin currently is not widely accepted, its use as a means of payment is growing. The causes behind the increasing acceptance of Bitcoin by merchants and users are mostly related to the low transaction costs. Eliminating middleman the transaction is verified by the network users themselves. Another reason could be that users that have not access to credit or debit card use the system as payment method and the same clients can prefer an anonymous payment system.

A study conducted by Bank of America Merrill Lynch[53] calculates the fair value of Bitcoin accruing its uses as medium of exchange and as a store of value. Regarding the former to reach a fair value some assumptions are needed. It is assumed that 10% of all the payments in the B2C sector are undergone in bitcoins, that the average ratio of consumption expenditures and household checking deposits in USA is 0.04[54] and that

[52] BBVA, Economic Watch, Bitcoin: a chapter in digital currency adoption, July 2013.

[53] BofA Merrill Lynch, Bitcoin: a first assessment, December 2013

[54] This means that US households are holding 4 cents in their cash for every $1 spent over the course of the year.

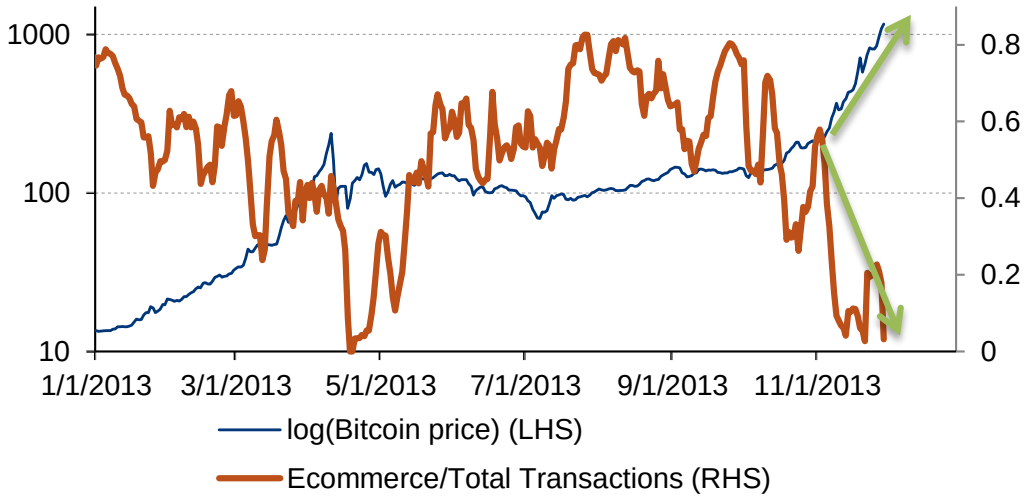
the B2C e-commerce sector totalized $224 billion in 2012. Being everything else equal $10bn are used by US households for the on-line shopping, of them it is assumed that the 10% are made using Bitcoin. In a macro perspective it is possible to multiply the $1bn of Bitcoins for the rest of the world, considering that the US GDP accounts for the 20% of world GDP. Doing so the value of Bitcoin used for the purchase of goods and services in the e-commerce roughly achieve the $5bn. But for medium of exchange it is included also the transfer of money around the world. In this case it is assumed that Bitcoin would be able to compete with the three major market players in the sector. To estimate the value of the cryptocurrency it is possible to use the valuation multiple-enterprise model, obtaining $4.5 bn. In conclusion the maximum market capitalization for Bitcoin's as a medium of exchange could be $9.5 bn.

However it is interesting to notice that the value calculated of Bitcoin as a medium of exchange, roughly around $9.5bn. is below its current market capitalization that reaches the $13bn. As a consequence bitcoins are used beyond e-commerce or money transfer.(Chart 4)

This theory is linked also to the high volatility of the cryptocurrency, which undermines its usage as a medium of exchange. Indeed it is noted

that as Bitcoin realized volatility increases, so the retailers accepting this form of payment is decreasing.[55]

Chart 4: Fewer transactions outside exchanges as prices rose



Source: BofA Merrill Lynch

Accordingly it is possible to assume that Bitcoin is also used as a store of value, as gold or silver. There are many elements in common between these two forms of store of value. Neither Bitcoin nor precious metals pays interest, both have a limited supply, the transaction made using Bitcoin or gold, for instance, are not traceable and Bitcoin like gold has a negative correlation with risk sensitive assets. Conversely Bitcoin is five times riskier of gold.

[55] BofA Merrill Lynch, Bitcoin: a first assessment, December 2013

The elements that make a commodity a good store of value are the follow: Stability and Substitutability, Ease of storage and Portability.

Differently from gold, silver or gases Bitcoin is more reactive or sensitive because of endogenous instability. The main ground is that the Bitcoin market is illiquid, then small shifts on the demand side can cause huge peaks and troughs. Regarding the substitution issue it is important to valuate whether competitors can erode the value of the good, undermining its usage. In this term Bitcoin is secured by competitors only for its position as first mover. But this advantage can be weakened by the explosion of other technologies similar to the Satoshi protocol that has been started up to fix Bitcoin system's flaws. The insurgents players are Litecoin and Ripple. However, they are not able to pose a serious threat yet.

A component that makes Bitcoin a good store of value is its ease of storage. The private keys that enable the spending of bitcons are cheaper, easier and more secure than gold. Moreover bitcoins transportation costs are very low, contrarily to gold. This easy portability is a robust point of difference which makes Bitcoin a good store of value. Nevertheless the elevated price volatility compromises this role. As a process that feeds on itself more the bitcoin price changes, more it will be rank by speculators that store their wealth in this currency only for instants

before bet on its fall. Speculators attack led to difficulties for a wide acceptance of the virtual currency by the large part of the population. Indeed people store their wealth forecasting period of crisis, for their old age and to endow their children, a stability in the long period in the commodity invested is an essential element for the choice of where storage their saves. While the value of gold is set by numerous forces, through the arbitrage that tied the gold's value to the other economic variables present in the free market, the one of the digital currency rises and falls due to fluctuations on its own market, making vary difficult for any investor to hedge their funds.

2.4 Is Bitcoin money?

The theoretical approach that is behind the assumption of Bitcoin as money can be found in the Austrian school. The prominent member of this theory is Friedrich Hayek whose book "The Denationalization of money"[56] has been kept by the Bitcoin network as the economic foundation of the entire system. Specifically the key concept elaborated by the author is that in general law tries to identify what is money and what is not, this distinction is based on the presence of a government that issue money,

[56] Hayek F.A., Denationalization of money: The argument refined-An analysis of the theory and practice of concurrent currencies, Institute of Economic Affairs, London, 3th edition, 1990.

therefore only in presence of a form of legal tender people adopt a currency without an intrinsic value.

On the contrary he stated that there can be currencies that have been not issued by a national government which imposes to all the members of its economy the acceptance of it. So there can be private businesses issuing their own forms of money. However these currencies are not legal for a long period.

According to Hayek money as the function of medium of exchange, not as theorized by the major monetary literacy, but in a different way this form of money have four kinds of uses: for cash purchases of commodities and services, for holding reserves for future needs, for deferred payments and as a unit of account in keeping books. The reason why money is accepted by the community is its scarcity, that is the element which grants value. In this perspective different currencies are characterized by their liquidity and stability.

Using the previous definition of money as medium of exchange, that combined the literature definition of money as medium of exchange, store of value and unit of account, it is possible to define Bitcoin money only in part. Actually Bitcoin is undertaken by users to provide a means of payment in the e-commerce sector and to process transaction in the cyberspace. While its usage for the storage of saves is undermined by the

high price volatility that implies the lack of security. For the same reason it cannot be possible to use it as a unit of account, because the instability produces the nonexistence of a fair value.

Another libertarian economist, Carl Menger, defines money using three different concepts.[57] One is that money have to be linked to trade, so only poor society without labor division not need such institution.

The second concept is tied with the quantity theory of money, for which money is an attribute. Lastly the liquidity of money determines whether or not goods can defined the utilization of such attribute.

Concerning the last definition, the liquidity element is fundamental to define money. For liquidity, Menger states spatial and temporal attributes.

The spatial attributes are uniformity, divisibility and the scope of acceptance. The temporal attributes include durability, storage costs. stability of value over time and stability of value in all market conditions. Scrutinizing Bitcoin on this point, its liquidity, it is possible to understand if for the Austrian libertarians Bitcoin is effectively to be considered money. Definitely Bitcoin accomplishes the spatial attributes, because it reduces the cost of transportation, roughly 1%, it is divisible and the system protocol should guarantee the security and protection from appropriation. The only component that is not well developed yet is the

[57] Oliver D., Are Bitcoin Money?, Committee for monetary research and education, June 2013.

widely acceptance, but, if the network will continue to grow at the present path, also this function will be fulfilled. In the temporal liquidity attributes the storage cost is the one that characterized Bitcoin as possible type of money. But neither the durability nor the stability of value can be considered an intrinsic attribute of this form of digital currency. Indeed the vast majority of the population do not have the ability to exploit the mining process, as a consequence they prefer to use the exchanges that trade bitcoin already mined, not contributing to the creation of new coins.

It is possible to conclude that in this perspective Bitcoin is not money but a transactional currency that need to be convertible to something else that has temporal value to became something more.

Bitcoin differs from conventional currency in many ways:[58][59]

- Precisely for how it was created, there is not a central bank managing the monetary policy, maintaining the system stability and providing financial service. Nonetheless part of those functions are conducted collectively through the peer to peer technology.

[58] Chowdhury A. and Mendelson B.K., Virtual currency and the financial system: The case of Bitcoin, Department of Economics, College f Business Administration, Marquette University, working paper 2013-09, 2013.

[59] Banco Bilbao Vizcaya Argentana (BBVA), Bitcoin: A chapter in digital currency adoption, July 2013.

- Another fundamental point of difference is the absence of a physical form of bitcoins, so a digital currency's owner is not able to convert into physical units its holds.
- Furthermore the limited cap of 21 million of bitcoin to be reach until 2040, pose a dividing line between the market law and the cryptocurrency operation. Even though central bank can fix the supply of money in circulation, throughout the fractional reserve banking it controls the total amount of money. This function is. in the virtual world, solved by the nodes of the peer-to-peer network. The number of Bitcoins generated per block is set to decrease geometrically, with a 50% reduction every 4 years. But this system does not take into account the network effect, for which the adoption of the currency can be faster than the response generating, as aforementioned, a deflationary spiral. Moreover the possibility to divide to eight decimal places one bitcoin, arriving to the smallest fraction called satoshis at $21x10^{14}$, should avoid at this stage an excessive appreciation of the currency.
- Bitcoin does not provide the feature of an interest rate. Interest rate are provided by central banks, that trough interest rate term structures derives it. Concerning Bitcoin the prices are quoted on

exchanges where the members. on the basis of the information gathered, will buy or sell it.[60]

- Since bitcoins cannot be created on demand. it is impossible to use it to make loans, since every loan need to made in actual bitcoins.[61]
- Bitcoin cannot be used at brick-and-mortar storefronts. While fiat money is universal accepted for all forms of payment.
- Transactions undertaken in bitcoins are irreversible, so it is not possible to be refunded by the receiver. On the other side in the boundaries of regulation with conventional currencies is possible to reverse a transaction for valid reasons by originator.

Once established that Bitcoin is not money, at least for now, can be interesting to analyze other options. The widespread opinion is that instead of currency it is an asset.

[60] Glaser F., Zimmermann K., Haferkorn M., Weber M.C. and Siering M., Bitcoin-Asset or currency Revealing users' hidden intentions, Twenty second European conference on information systems, Tel Aviv,2014.

[61] Hanley B.P., The false premises and promises of Bitcoin, December 2013.

Chapter 3

Why do Bitcoin exchanges quote different prices?

3.1 Arbitrage opportunities

One reason of the Bitcoin success is the possibility of arbitrage in different trading venues. These are the platforms that trade Bitcoin to other currencies. If the price of Bitcoin expressed in dollar is different across the exchanges, thus the investor as some opportunities to make profit going short[62] where the price is high and long[63], on the contrary, where the price is low. The price differentials lead to arbitrage opportunities that can be seen as market inefficiencies. This raises some questions as "what determines the price differential?" or "Is the deregulation of the cryptocurrency a determinant of the arbitrageurs profit?".

These opportunities can be exploited also by individuals that are not

[62] In finance, short selling (also known as shorting or going short) is the practice of selling securities or other financial instruments that are not currently owned, and subsequently repurchasing them.

[63] In finance, a long position in a security, such as a stock or a bond, or equivalently to be long in a security, means the holder of the position owns the security and will profit if the price of the security goes up.

usually involved in FOREX operations, because there are not futures or swap contracts, the contractor can only stipulate spot contract. Nevertheless the feasibility of this, at first sight, easy opportunity can be undermined by the high risk of hacker attack that the trading platform cyclical received or by the high fees that the exchanges demand to withdrawal the money outside the wallet to be transfer in the bank account.

Conversely of what it is thought the low transaction fees are only related to the transaction in Bitcoin but once the owner of the cryptocurrency decides to exchange it for other currencies, or when an arbitrageur decides to exploit exchange rate unbalances, then they have to bear high cost of ownership.

A fundamental principle in microeconomics is the "law of one price". The law of one price assesses that "a good must sell for the same price in all locations"[64], when expressed in the same currency. This means that in a perfect market for one and the same good no two different prices exist. While on traditional financial markets still occasionally appear inefficiencies and thus arbitrage opportunities arise, these can be consistently observed in the Bitcoin market. Trading places like Campbx

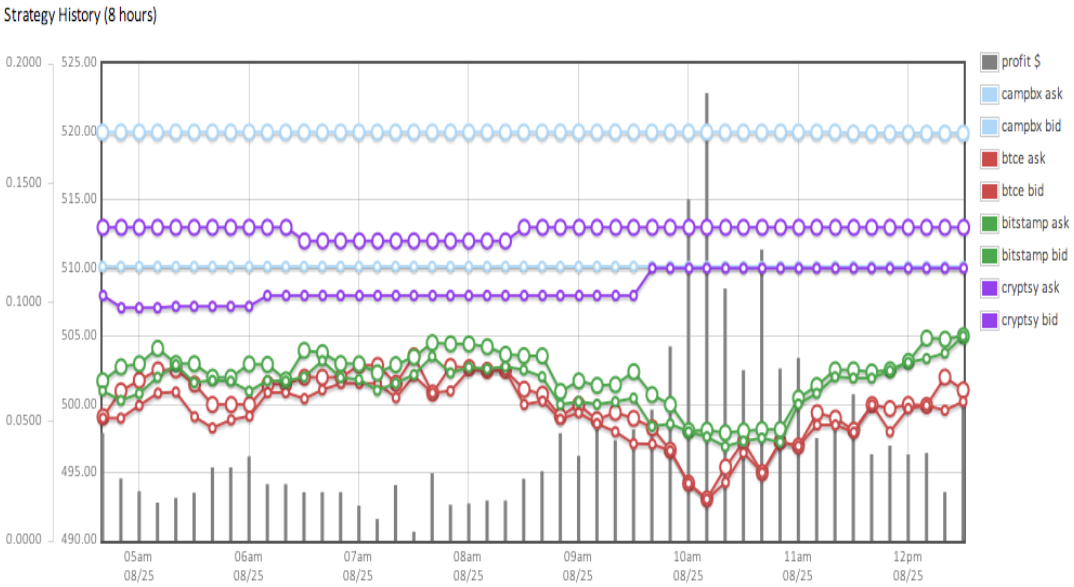
[64] Mankiw. N.G., Principles of Economics, 6th edition, Mason, South-Western Cengage Learning, p. 686, 2011.

and BTCe have temporarily high rate differences of up to ten percent, and thereby enable the use of price differentials[65].

On Cointhink.com a BTC/USD Arbitrage Strategy suggested was to transfer USD through BTCe, buying $39.95, then transfer BTC to Bitstamp, where it is possible to sell $1 for 0.07315 BTC or Campbx, for $1 equal to 0.00287 btc. (Graph 1)

For the monitored exchanges, the total value of offers that have immediate buyers is $40.03. Selling immediately, including market fees, earns $40.09 for a profit of $0.06 (0.141%).

Graph 1: Bids/Asks and profit



Source: Cointhink.com

The differences can depend directly on the exchange platforms on the

[65] Petrov A. and Schuffla D., Arbitrage am Bitcoin market, 2013.

basis of the trade volume, the transaction fees or the legislation to which the exchange is in compliance. On Internet also exist a number of arbitrage tools that support the arbitrageurs. Some of these tools even allow the fully automated action[66].

The knowledge about afforded arbitrage opportunities makes it possible, at least theoretically, at a risk-free profit. But this theory is workable in practice? With regard to this question the study will take an overview of the variables that can affect the spread among the Bitcoin market.

In the following paragraphs will be explained first the basics of arbitrage. In addition will be described further the different types of arbitrage.

After the basic knowledge have been described, followed by the main part. The regression model is built to rate the elements that lead to the worthlessness of the Law of One Price.

Arbitrage generally refers to the realization of a riskless profit by simultaneously buying and selling the same commodity in two different markets[67]. In the currencies market the arbitrage is described as a forex strategy in which a currency trader takes advantage of different spreads offered by brokers for a particular currency pair by making trades. Different spreads for a currency pair imply disparities between the bid

[66] Bitcoin-analytics.com

[67] Shleifer A. and Vishny R., The limits of arbitrage, The Journal of Finance, n. 52. 1 (1997), pp. 35–55, 1997.

and ask prices.

An example of this strategy can be that in A one euro is exchanged for two dollars, while one euro exchanged in B is equal to two dollars and one cent. An arbitrageur could buy USD in A and then simultaneous sell it in B. In this way on each purchased he will earn a profit of $ 0.1. In a transaction with sufficient large volume, the increased demand in A and the simultaneously increase in B's supply will align the price differential. As a result arbitrage plays a crucial role in financial markets, in that it allows standardization of the markets and thus their efficiency.

There are many types of arbitrage. In this paragraph will be treated the statistical arbitrage (StatArb), the uncovered and covered interest arbitrage and the exchange rates arbitrage. For the latter two different exchange possibilities will be scrutinized: the two-point and the three-point arbitrage.

The StatArb is based on the mispricing of one or more assets based on the expected value of these assets. The mostly used example by the literature[68] to define that type of arbitrage is the coin game. For example, consider a game in which one flips a coin and collects $1 on heads or pays $0.50 on tails. In any single flip it is uncertain if one will win or lose money.

[68] Avellaneda M. and Lee H., Quantitative finance, Statistical arbitrage in the US equity market, 2010.

However, in the statistical sense, there is an expected value of for each flip:

$$\$1 \times 50\% - \$0.50 \times 50\% = \$0.25$$

According to the law of large numbers, the mean return on actual flips will approach this expected value as the number of flips increases. A trader will repeat the same trading strategy in the long-run to meet these expectations.

Besides the above arbitrage type, based on the value of good, there is another variant of the arbitrage, the interest arbitrage. It plays an important role in the foreign exchange market. The simplest form of interest arbitrage is the uncovered interest arbitrage. This is a form of arbitrage that involves the interest rate on the deposit between different countries. Suppose that an investor has $5000. The deposit interest rate in Usa is i$= 3.4% for this reason if he holds the money in Usa at the end of the year he will receive $5.170.00. While in the Euro zone the deposit pays an interest equal to i€= 4.6%. The exchange rate at the starting point to bring the money in Europe is USD/EUR equal to 1.2730. In this scenario after one year the value of EUR/USD will be equal to 1.2820. At the end the investor will receive $5.266.976 only moving the currency. The problem of this arbitrage strategy is that the value of the dollar can float without restrictions or the Federal Reserve can change its monetary policy out of the forecasted expectations; in these cases the arbitrageur runs the risk to

lose money. Therefore, there is the so-called covered interest arbitrage, in which an investor hedges his position against exchange rate risks with futures or forwards contracts. Futures and forwards are contracts in which two parties agree at a future date to conduct business with certain conditions. The main difference between futures and forwards is that forwards contracts are individualized, whereas futures are standardized[69]. It is possible to use the aforementioned example to explain the covered interest arbitrage. Indeed the only difference to the uncovered one is that the parties agree to enter a forward contract smoothing the risk associates to exchange rates fluctuations. Holding all else equal, investors decide to fix the exchange rate to convert again the EUR deposit into dollar at EUR/USD equal to 1.300. By doing so the investment will be

$$(1+i\$)= F/S(1+i€)$$

where F is the forward, S(1+i€) is the spot rate compound for the EUR interest rate. Although this type of arbitrage is used in currency markets, they cannot be transferred to Bitcoin at the current time because in the Bitcoin market are not yet available that types of standardized contracts.

Under exchange arbitrage it is possible to realize a risk-free profit simultaneously purchasing and selling currencies, understood the

[69] Jarrow R.A. and Oldfield O.S., Forward contracts and futures contracts, Journal of Financial Economics, 1981.

peculiarity of each market. For this type of arbitrage opportunity it is possible to engage a two-point arbitrage or a three-point arbitrage, also called triangular arbitrage.

The first one it is based on inconsistencies between exchange rates in two different markets. The extension of that is the triangular arbitrage, which involves three different currencies. Suppose that €1 buys $2, while with $1 it is possible to buy 3 bitcoins that have a value equal to €0.25. An arbitrageur can make a profit buying for €1 $2 and then exchanging them simultaneously in 6 bitcoins and sold these in turn at the same time for €1.5. Therefore, a profit of €0.5 is reached, basically at a risk free rate.

In the Bitcoin market those opportunities to exploit price differentials are scalped in different trading platforms rather than in different geographic market. Disparity between prices in different Bitcoin exchanges is significant, due to inefficiencies in this specific market. Considering whether a good news spreads on internet about the acceptance of Bitcoin. for instance the acceptance from Ebay of the cryptocurrency, people will start to buy more bitcoins on the larger exchanges as Bitstamp, doing so they drive the price of bitcoin up. At the same time, smaller exchanges in term of volumes, as CampBX, are slower in reacting to those information and so the price in their trade venues is lower. The situation remains as described until arbitrageurs buy bitcoin on CampBx at a lower price and

sell it on Bitstamp at a higher price obtaining a risk free profit.

Nevertheless there are some inadequacies of the market that deter investors form scalping the market. The main risks are linked to the low liquidity of the market, to the unpredictable volatility of the currency and to the high fees for withdrawal.

However arbitrage opportunities across platforms are still possible especially in those exchanges where it is possible to trade Bitcoin for different currencies in exchange.

3.2 Regression Model

To assess the Bitcoin arbitrage opportunities across exchanges it is fundamental to understand the reasons behind the spreads in the bitcoin value on these platforms. In order to scrutinize the market drivers hidden behind each price differentials a multiple regression model has been built:

$$\text{Spread} = \alpha + \beta \text{ Log(Daily vol.)} + \beta \, \Delta\% \text{ exchange rate} + \beta \text{ inflation rate} + \varepsilon$$

The model was constructed following the research method proposed by Moore and Christin (2013)[70]. In the paper "*Beware the Middleman: Empirical Analysis of Bitcoin-Exchange Risk*" the authors point of view is focused on the risks related to the Bitcoin exchanges, but the way in which they

[70] Moore T. and Christin M., Beware the Middleman: Empirical Analysis of Bitcoin-Exchange Risk, 17th International Conference, FC 2013, Okinawa, Japan, pp 25-33, April 1-5, 2013.

represent their analysis point out the predominant role of the exchanges in the Bitcoin fluctuations.

However before constructing a multiple regression the data collected where put in a simple linear regression and analyze under an ANOVA test to examine whether each variable singularly characterized the independent variable. Before the ANOVA table, the correlation where scrutinize in the dispersion graphs. The daily volumes were not observable in a dispersion graph due to their magnitude for this reason in the multiple regression the data related on this variable has been transformed in logarithmic base.

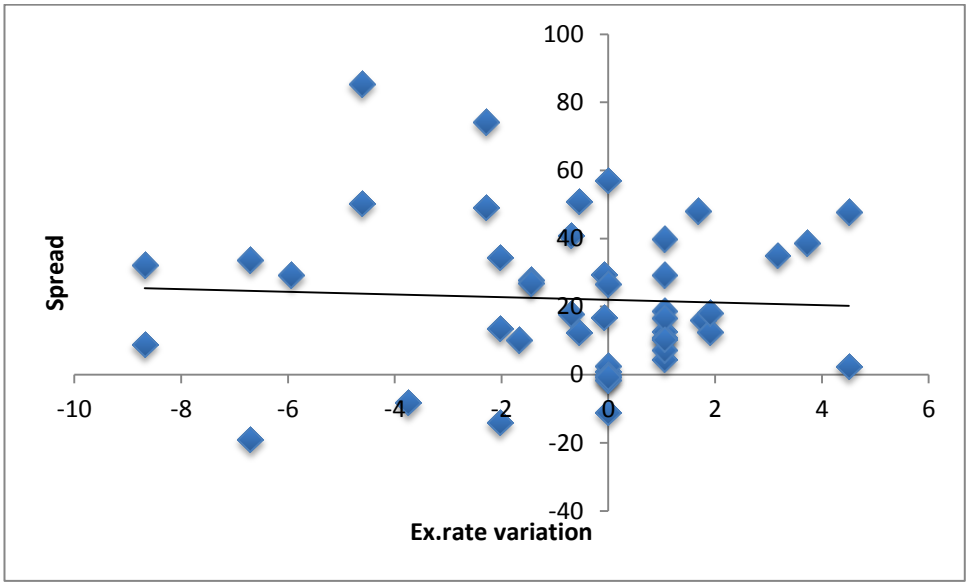
Then the study held on using the multiple regression model. The general purpose of multiple regression (the term was first used by Pearson. 1908) is to learn more about the relationship between several independent or predictor variables and a dependent or criterion variable.[71]

The dependent variable is the spread between Bitstamp.net and all the other 48 exchanges analyzed. The independent variables that should drive the "y" fluctuations are the transaction volume, for the data has been used a logarithmic transformation given how skewed transaction volume is, the percentage variation of the exchange rate and the inflation rate. It is

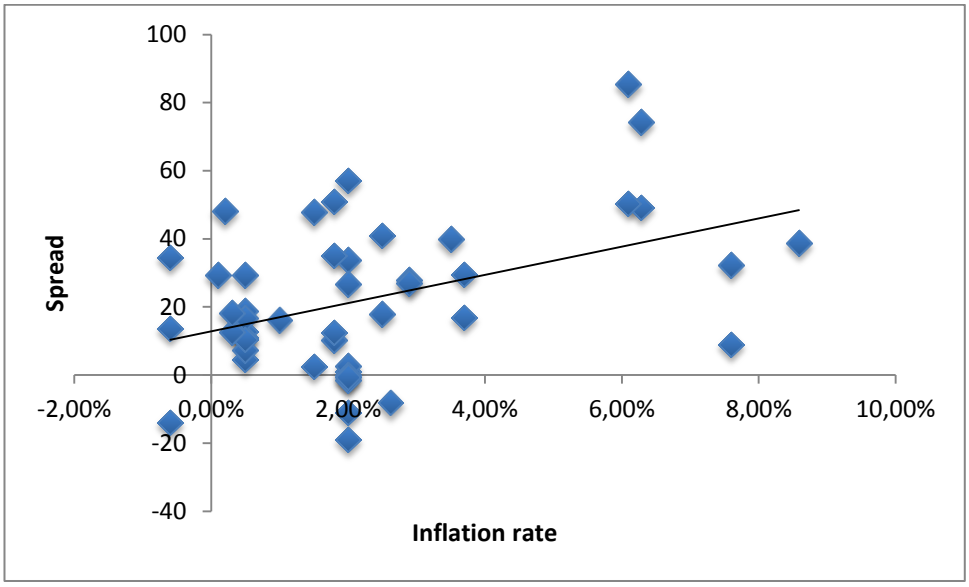
[71] Berenson M.L., Levine D.M. and Krehbiel T.C., Basic Business Statistics, Pearson/Prentice Hall, 2009.

expected that higher transaction volumes lead to a lower difference between the prices at which a bitcoin is traded across platforms.

Graph1: Spread and Variation in the exchange rate



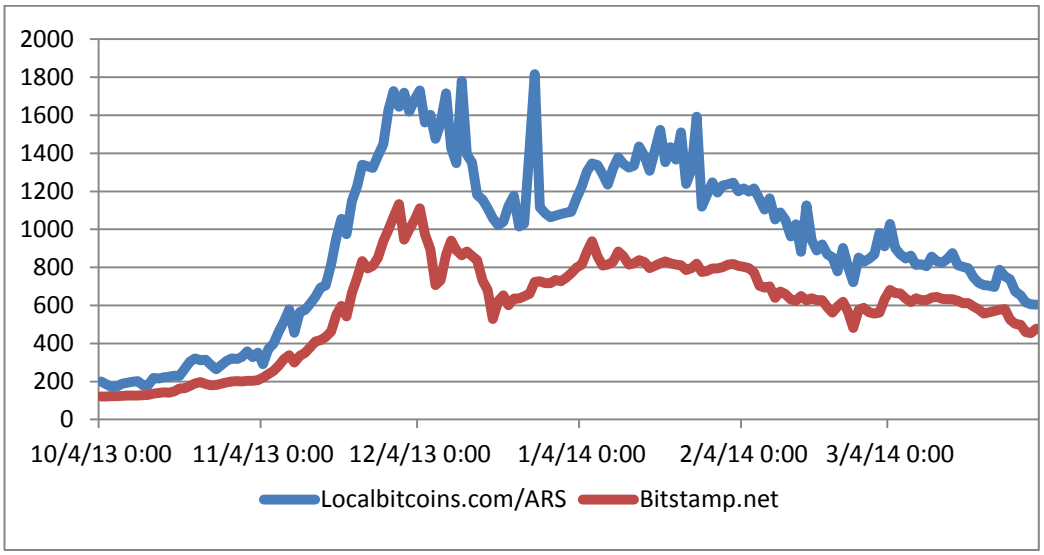
Graph2: Spread and inflation rate



Moreover it is expected that higher is the variation in the exchange rate lower should be the spread.

Finally higher is the inflation rate higher should be the spread. Indeed people that live in country with high level of inflation are more favorable to invest in a currency built to avoid hyperinflation spiral, leading to an increase in the spread. (Chart 1)

Chart 1: Weighted price of bitcoin on Bitstamp.net and Localbitcoin.com[72]. expressed in dollars.



Data Source: Bitcoincharts.com

[72] LocalBitcoins.com is a person-to-person bitcoin trading site. At LocalBitcoins.com people from different countries can exchange their local currency to bitcoins. The site users post advertisements where they state exchange rate and payment methods for buying or selling bitcoins. You reply to these advertisements and agree to meet the person to buy bitcoins with cash. or trade directly with online banking. Bitcoins are placed in LocalBitcoins.com web wallet from where you can pay your bitcoin purchases directly.

It is hypothesized that trading volumes, inflation rate and exchange rate are related to the price for which a bitcoin is sold in different exchanges.

Firstly the null hypothesis is that in the population there is no relationship between the volume and the spread controlling for exchange rate variation and inflation rate.

Secondly in the population there is no relationship between exchange rate variation and spread controlling for volume and inflation.

Thirdly in the population there is no relationship between inflation rate and spread controlling for volume and exchange rate variation.

3.3 Data presentation

The study begins by collecting historical data on the Bitcoin exchange rates maintained by the website bitcoincharts.com. This includes the daily trade volumes and weighted daily price for 49 Bitcoin exchanges converting into 22 currencies for six months until April 1. 2014, when the data collection was made. It has to be noticed that Mt.Gox exchange is not part of the database due to its closure on February 2014.

All the different currencies were converted into dollars, at daily exchange rates, because the USD market is more liquid than the other markets and for this reason there is more space for arbitrage opportunities. Another reason behind the choice of the dollar is that the benchmark platform

(Bitstamp.net), that will be used to calculate the spread among the websites, trades especially in dollars. Where the data were not available, because the websites suffered an attack, in those days both the daily volume and the average weighted price were calculated as the mean of the day before and after the hacker attack. Concerning the average daily transaction volume, made in bitcoin, bigger exchanges are more homogeneous in the price traded for each bitcoin. Thus an increment in the volume traded by the smaller exchanges makes that possibility of scalping lower. Therefore the alignment in the daily volume traded in the exchanges, implies a similar alignment of the prices between those actors.

The other independent variable analyzed for the study is the exchange rate at which each currency related to a platform, and so exchanged versus Bitcoin in the first place, is traded versus dollars. Regarding the percentage variation of each most traded currency (FC. foreign currency) in each platform versus US dollars, the formula used for the calculation is

$$\Delta E_{\$/FC} = [(E_{\$/FC\ t+1} + E_{\$/FCt})/ E_{\$/FCt}]$$

Furthermore the analysis is built in order to assess whether the inflation rate of the country, which issues the most traded currency of the platform, is linked to the discrepancies in the Bitcoin price.

Say that Mercado Bitcoin is an exchange, which trades bitcoins (BTC) versus Brazil Real (BRL). Firstly, given the fact that the data about this

platform are not in dollar it is used the daily exchange rate of the BRL/USD to have all the values in the same unit of account. Therefore it was calculated the variation of the BRL during the period considered to identify eventual relations between the Bitcoin price in this venues and in Bitstamp.net. If there are connections this may mean that Bitcoin is used in a triangular arbitrage.

Regarding the inflation rate variable in the case of Mercado Bitcoin was analyzed the inflation rate of the Brazil, all the data relative to the inflation rate are of the last quarter of 2013. If the most traded currency in the exchange is not linked to the physical place where the platform is incorporated, then the inflation rate has been linked to the country that issues it, not to the place where the platform is based. For instance Bitfinex.com is incorporated in the British Virgin Island but on the website it is possible to exchange bitcoins for dollars. In this case the inflation rate used was the one of the United States; the same happened for TheRockTrading.com, which is a Cypriot company but trades mostly in dollars.

Other independent variables have been subject of the analysis, nevertheless those variables were not correlated to the spread and for the same reason are not included in the final result. Those were the transaction fees of the exchange, the number of breaches suffered by the

platform and the extent to which the exchange's jurisdiction has implemented "Anti-Money Laundering and Combating the Financing of Terrorism" (AML) international standards. The data related to the transactions fees were collected on each platform and each time the platform guarantees a different fees on the basis of the volume traded, the resulting transaction fees for the model was calculated as the mean of the highest and the lower one. The reason why this variable is not significant for arbitrage aim could be that fees are low and almost the same in all the trading venues analyzed so under this circumstance this cannot be considered an explanatory variable of the spread. But it was likewise important as result because if the transaction costs are low, identical items should be traded at almost the same prices. Instead the law of one price does not hold every time in this market, so there must be something else. With regard to the security breaches the scrutiny was based on the bitcoincharts.com and then confirmed by the Bitcoin community and forums. In this case it was expected that more security breaches the exchange suffered, less attractive this could be for investors and so the owner should guarantee more profit due to the lower safety measures. But also this variable is not considered significant because in the Bitcoin market the target of the hackers are mostly the bigger exchanges, while the smaller, when suffered such attacks, are forced to close because they do

not have the liquidity to repay the wallet stolen. So the hacker attacks generate a different phenomenon[73] but not the one of the different prices in different exchanges.

Finally, to assess regulatory impact, the study attempted to identify the country where each exchange is based. Then it is used an index (ranging between 0 and 49) computed by World Bank economists to identify each country's compliance with "Anti-Money- Laundering and Combating the Financing of Terrorism" (AML-CFT) regulations. The AML index has not able to suggest the reasons of platforms differences, probably because it is linked to the physical place where the exchange is incorporated and so it is not interesting for the scope aforementioned.

3.4 Results

The Bitcoin arbitrage opportunities are linked to its internal market, because it has not ties with exogenous factors that usually determine the trend of an asset[74]. Considering that Bitcoin rate of return differs from those of other assets as gold, oil and hedge funds. (Table 1)

[73] Moore T. and Christin N., Beware of the Middleman: Empirical Analysis of Bitcoin-Exchange Risk, Financial Cryptography and Data Security, 17th International Conference, Okinawa, Japan, pp 25-33, April 2013.

[74] Brière M., Oosterlinck K. and Szafarz A., Virtual currency tangible returns: Portfolio diversification with Bitcoin, CEB Working paper, N. 13/031, September 2013.

Even so the Bitcoin price formation have some peculiarities, because the elements that are positively associated with bitcoin fluctuations are different from the usually factors that generate asset or currency volatility.[75]

Hence those whom would to exploit that opportunities are mainly arbitrageurs that what to scalp the market inefficiencies in the short-term.

Table1: Descriptive statistics, weekly returns. 23 July 2010-12 July 2013

	BTC	EUR	JPY	Stocks Dvp	Stocks Emg	Gvt Bonds Dvp	Gvt Bonds Emg	IL Bonds Wld	Corpo Bonds Wld	Gold	Oil	Real Estate	Hedge Funds
Mean	7.14%	0.01%	0.10%	0.27%	0.07%	0.05%	0.12%	0.11%	0.12%	0.08%	0.26%	0.18%	0.02%
Ann. Mean	371.14%	0.39%	4.95%	14.27%	3.56%	2.37%	6.24%	5.52%	6.12%	4.05%	13.56%	9.13%	1.24%
Median	2.93%	0.07%	-0.11%	0.44%	0.09%	0.07%	0.24%	0.06%	0.14%	0.31%	0.37%	0.39%	0.12%
Maximum	137.62%	4.17%	3.97%	8.27%	9.46%	2.25%	2.40%	2.28%	1.83%	7.14%	13.51%	5.91%	0.90%
Minimum	-41.78%	-3.19%	-3.55%	-8.81%	-11.62%	-2.85%	-5.90%	-3.51%	-2.55%	-7.11%	-14.57%	-9.04%	-2.49%
Std. Dev.	24.22%	1.45%	1.34%	2.31%	2.70%	0.86%	1.01%	0.97%	0.72%	2.50%	3.72%	2.09%	0.48%
Volatility	174.66%	10.49%	9.65%	16.67%	19.49%	6.22%	7.26%	6.97%	5.20%	18.03%	26.86%	15.05%	3.43%
Skewness	1.99	0.24	0.27	-0.42	-0.26	-0.25	-1.66	-0.20	-0.31	-0.24	-0.22	-0.74	-1.38
Kurtosis	10.05	2.77	2.93	5.05	6.04	3.29	10.71	3.48	3.66	3.71	4.93	5.63	7.34
Sharpe ratio	2.12	0.02	0.49	0.84	0.17	0.35	0.83	0.76	1.14	0.21	0.50	0.59	0.30
Observations	155	155	155	155	155	155	155	155	155	155	155	155	155

Source: CEB

[75] Glaser F., Zimmermann K., Haferkorn M., Weber M.C. and Siering M., Bitcoin-Asset or Currency? Revealing users' hidden intentions, Twenty Second European Conference on Information Systems, Tel Aviv, 2014.

All this situation has burst a bubble, the basis of which can be reconnected to the excessive media coverage, to the network effect (Figure 3.1), to the lack of trust in financial institution and in general to the unforeseeable economic picture.

It is shown[76] that an increase in Bitcoin participants is positively associated whit an increase in the Bitcoin exchange volume. Users buy in Bitcoin as an alternative asset, lacking a valid valuation method, their expectations about future prices are only based on any information reachable on the internet community, social media, newspaper articles, friends or peers. Negative news are likely to not influence prices because the users are aware of the high risks associated to the cryptocurrency once they buy it. On the contrary positive news attract new users or state old users to stay invested. This investment behavior characterized how Bitcoin is a high speculative investment vehicle. Studying[77] the relationship between Bitcoin price and search queries, it is revealed as not only the amount of search queries on Google or Wikipedia influence the prices but also the opposite is true. For the literature the relationship can be seen as the

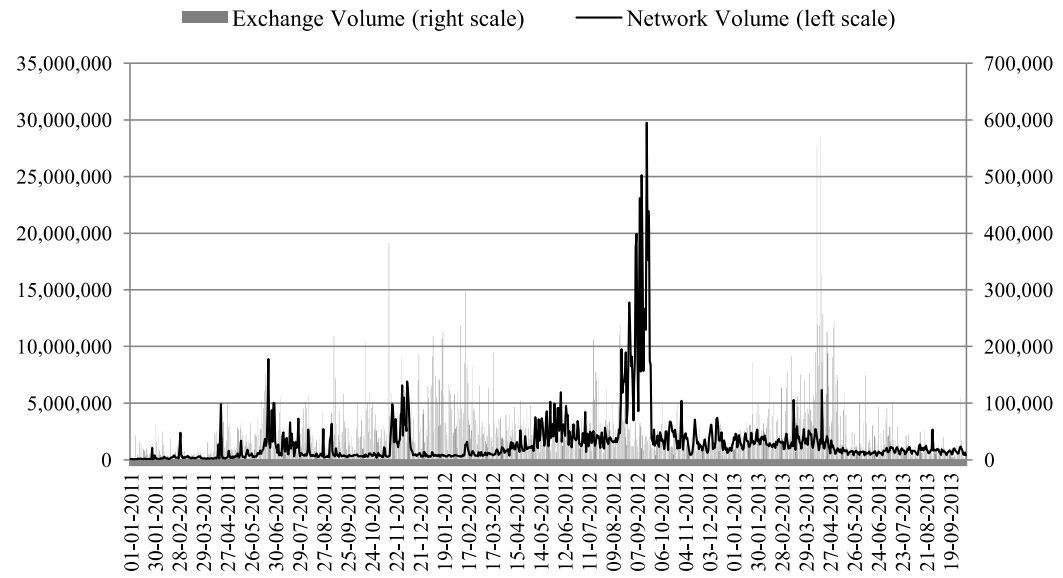
[76] ivi.

[77] Kristoufek L., Bitcoin meets Google trends and Wikipedia: quantifying the relationship between phenomena of the internet era, Scientific Reports, December 2013.

explanation of the Bitcoin as a financial asset with no underlying fundamentals.

For the analysis conducted in this thesis the study is focalized on the prices of the different platforms instead of the price of Bitcoin. Hereafter once it is recognized by the literature that Bitcoin is used for speculative purposes, it is necessary to research the drivers of this behavior. Under the study some variables that are the drivers of the spread across the exchanges have been identified. The choice to analyze the exchanges is connected to the ecosystem into which it is possible to find space for such opportunities.

Figure 1: Bitcoin Exchange and Network Volumes



Source: Twenty Second European Conference on Information Systems (2014)

The variables are the daily trading volumes, the variation in the exchange rate and the inflation rate.

The multiple linear regression yields the following results:

Spread	**Coef.**	**Std.Err.**	**t**	**P>t**
Log.(Volume)	-9.380**	4.705	-1.99	0.049
Δ% E$/FC	-5.891***	1.231	-4.78	0.000
Inflation rate	452.397**	236.526	1.91	0.050
_Cons	25.040**	10.733	2.33	0.024

N.of obs.	F(3,44)	Prob>F	R-squared	Adj. R-squared	Root MSE
48	22.29	0.0000	0.6032	0.5761	33.106

The summery statistics shows that the 60.32% of the variance of the response variable Spread is explained by the regression run, while the adjusted R-squared takes into account also the number of observations, therefore the 57.61% of the variance of the Spread is explained by the model.

The t-test shows a quite low p-value for the explanatory variable volume and so there is evidence to reject the null hypothesis of the no relationship between spread and volume. There are evidences to suggest that there is a relationship, and so reject the null hypothesis, also for the independent variable exchange rate, which has a very low p-value.

Furthermore there is some evidence to reject the null hypothesis, controlling for the low p-value, for the inflation rate. So also for this case it is possible to suggest that there is a linear relationship between spread and inflation rate controlling volume and exchange rate in the population.

Moreover it is possible to see that the volume coefficient is negative, meaning that as the daily volume traded increases the spread decreases.

The same is true also in the case of the exchange rate variation, being the coefficient of the explanatory variable negative as well. While the coefficient's result for the inflation rate shows that as inflation rate increases the price differentials also increasing.

More in details it is possible to observe that when the volume exchanged on the platforms increases, the prices of Bitcoin will flatten reducing the spread and the possibility to speculate in the space.

Vis-à-vis the variation in the exchange rate, it is noticed that when it increases the spread decreases, because the coefficient is negative. Definitely when the variation increased this means that there is a depreciation of the foreign currency (FC). The foreign currency is the one traded in a different value than dollars. Thus the value of the bitcoin has strengthened, because investors will buy Bitcoin to exchange the foreign currency into dollars to purchase goods in the latter currency rather than

in the depreciated currency. In this context Bitcoin is used as both a means of payment and a financial asset.

Therefore the difference between the benchmark exchange, which trades in USD, and the one of the depreciated currency will be lower, because the price of bitcoin in the depreciated foreign currency will approach the price in the benchmark platform in dollars.

Finally a rise in the inflation rate in a country where it is possible to exchange Bitcoin generates high price differentials between a bitcoin exchanged in platforms linked to country with low inflation rate and in contrast on those with spiraling inflation, as Argentina. The raison d'être could be that for how it was designed the cryptocurrency cannot generate inflation, being its supply limited in time.

Conclusion

The peer to peer electronic cash system is playing a predominant role in the virtual currency systems. Bitcoin price movements have captured economists' interest especially for the increasing daily transactions performed using this form of payment. The growing attention toward this phenomenon led the drafting of this analysis, which has the final purpose to analyze the market variables that drive the Bitcoin trend.

In chapter one was introduced the concept of virtual currency with the history of money in order to demonstrate the evolution in the monetary market caused by the born of new schemes. These are analyzed following the description made by the European Central bank, focusing on the virtual currency schemes with bidirectional flow. Those are systems that have a direct connection to the real world. Firstly because to hold them it is needed to exchange the cryptocurrencies versus fiat currency. Secondly because it is possible to exchange them back from the virtual world to the real one. Subsequently it's been discussed the ecosystem into which this money operates, trying to delineate some differences with legal money. The preliminaries differences arisen are related to a centralized or decentralized monetary system and to the anonymity of the owner of

digital versus fiat currency. In order to give a more specific overview, some virtual currencies have been proposed, of them the most adopted are Bitcoin and Litecoin. Finally it is possible to find an international overview of the legal framework relative to this issue. In fact many authors stressed how the lack of regulation has attracted fraudulent actors in this market, sometimes engaging Ponzi schemes. It is given a more deep analysis based on the US regulation and to the declaration of the Internal Revenue Service of the US Government that on March 2014 released a definition of Bitcoin and similar currencies. In their point of view rather than considering those as a form of money, they should be treated as an asset, and for that scope taxed as income on the basis of fair market value as of the date of the specific activity.

In chapter two it is given an overview on Bitcoin and on the reason why it is an interesting topic to study. The first element that draws the attention is the way in which it is possible to define Bitcoin. It is a decentralized peer to peer network, Bitcoin with the capitol "B", but also a unit, with the little "b". To acquire bitcoin the clients can mine it or exchange it for other currencies on various platforms.

In order to perform the transaction in bitcoins, there a two components to look at, one is the Blockchain and the other is the keypairs. The protocol so designed has some advantages, as described in the third paragraph. It is

not needed a central institution clearing the transactions, there are not middleman therefore the transaction fees are very low, clients can perform the deal anytime anywhere consequently no cost of transportation or storage and security are reported. Another point of strength is the anonymity of the transaction, which is, however, verifiable in the blockchain. Moreover in the merchants standpoint the transaction are not reversible. In an economic prospective some authors see in the limited supply the possibility to fight against inflation.

The disadvantages stressed can be summarized as the follow: the price volatility, the security risks, delayed confirmation time, the double spending problem, the probable deflationary spiral, the absence of a derivative market and so the possibility to hedge investor's position against bitcoin rises and falls.

To better understand how it is possible to classify Bitcoin the chapter hold on studying its uses as medium of exchange and store of value, citing the report of Bank of America Merrill Lynch. It is evident that bitcoin is getting the mainstream as means of payment for the aforementioned advantages in its usage. While it is not easy to assess whether it is also a store of value. The conclusion is that for now it cannot be considered for that application. But this led the discussion toward the identification of this form of currency as money or not. In an Austrian school perspective,

Bitcoin has the function of money, anyway it lacks in stability and durability of value. At the end it is defined as a transactional currency. Many are the differences between Bitcoin and money, for how it was created and developed, for how it is spendable and for how it is manage in a monetary policy point of view. So Bitcoin has to be considered an asset rather than money.

The research part of the thesis is centered around the arbitrage opportunities that investors seek on the currency exchanges. At this aim the third chapter reports firstly the arbitrage opportunities that can be exploited in the market, as the statistical, interest rate and currency arbitrage to then focalize the work on the specific virtual currency conditions.

The regression model constructed wants to describe the hidden drivers of the bitcoin prices differentials across platforms. It is hypothesized that trading volumes, inflation rate and exchange rate are related to the price for which a bitcoin is sold in different exchanges.

Firstly the null hypothesis is that in the population there is no relationship between the volume and the spread controlling for exchange rate variation and inflation rate.

Secondly in the population there is no relationship between exchange rate variation and spread controlling for volume and inflation.

Thirdly in the population there is no relationship between inflation rate and spread controlling for volume and exchange rate variation.

The results of the model show how it is possible to reject the null hypothesis for all the three explanatory variables.

The t-test shows relative low p-values for the independent variables volume, exchange rate and inflation rate. Moreover the coefficients explain the way to which those variables affected the responses variable spread.

The daily volume has a negative coefficient meaning that as the volume traded by a platform increases, the spread between the platforms decreases. That happened for two different reasons. One is that an increase in daily volume can be generated by a network effect so the population after a positive or a negative news act on big platforms, leaving the small platforms reacting on price movements slowly. But another reason is that to exploit a successful arbitrage strategy, the investor will buy where the price are low to sell the same currency on platforms where the price are high. The movements in supply and demand in the long-term generate a balance between bid and ask on the platforms use to trade, flattering the price differentials.

Regarding the variation in the exchange rate, also for this variable the coefficient in negative, meaning that as the variation in the exchange rate increases the spread decreases. Hence when the variation in the exchange

rate increases, the underlying currency has been depreciated. The devaluation of the foreign currency into which the Bitcoin is expressed in platforms different from the benchmark led to an appreciation of the Bitcoin. As a consequence the spread between those platforms decreases approaching the price of Bitstamp.com expressed in dollars.

Finally the coefficient of the inflation rate is positive. Probably this is the most important evidence because highlights the possible use of the currency as a store of value in country that fight against hyperinflation. The relationship is the follow as the inflation rate increases the spread increases as well, amplifying the distance between the price quoted by a platform which trades a currency of a country with high inflation, and the one that trades currencies of stable countries.

The analysis has of course some point of weaknesses. Firstly the time series is of only six months. The choice of this period was determined by the limited amount of the same exchange platforms in longer period, for the high turnover in the exchanges. A lot of exchanges are opened only for few months while other shut off after a long activity, as Mt.Gox. But if the bitcoin market will continue to stabilizing, then an analysis of more periods will be feasible, thanks to more actors that will be able to remain in the market. The analysis can have a bias, because are analyzed both intra-platforms and inter-platforms prices. Nevertheless the former are

connected to the website Localbitcoins.com, that shows the exchanges for the major currencies in circulation.

For further analysis could be also interesting analyzing more in detail the relationship between the inflation rate and bitcoin prices movements to stabilize the store of value role of this currency, in order to scrutinize if in the future it develops as money.

Appendix

The Dataset below report the value relative to the Spread, the volume, the fees, the breaches, the AML index the variation of the exchange rate and the inflation rate for the exchanges analyzed.

Timeseries: 4 October 2013- 4 April 2014

Exchanges	Spread Price USD	Volume (BTC)	Fees	Sum Breaches	AML WB index	Variation Ex.rate	Inflation rate Q4 2013
Local ARS	339,8319455	4,244333333	1,00%	7	20,33	-27,43100553	10,90%
Btcmarket AUD	27,93849472	16,21438889	0,80%	4	21,33	-1,450591326	2,90%
Local AUD	26,88302439	75,80922222	1,00%	11	20,33	-1,450591326	2,90%
Local BRL	74,27035791	3,880986111	1,00%	20	21,33	-2,288256338	6,28%
Mercado btc	49,14321575	69,70977778	1,99%	0	21,67	-2,288256338	6,28%
Local btc CAD	33,72643245	28,6525	1,00%	0	20,33	-6,702935753	2%
Virtex CAD	19,00967698	526,6509444	1,50%	0	20	-6,702935753	2%
Local btc CHF	48,11821604	10,05226389	1,00%	35	20,33	1,682259806	0,20%
BTC CHINA	10,17005712	25179,989	0,50%	0	23,16	-1,664506029	1,80%
Local BTC CZK	29,24230627	3,3425625	1,00%	14	20,33	-5,932330545	0,10%
Bitcoin Central	12,7832843	108,2731111	0,50%	1	20,67	1,057043494	0,50%
BitCurex	4,498420114	51,09333507	0,40%	5	19,67	1,057043494	0,50%
BitCoin.de	10,8764331	936,2971111	1,00%	0	20,67	1,057043494	0,50%
BTC-e EUR	7,281353694	435,5285	0,20%	0	29	1,057043494	0,50%
Cryptotrade EUR	18,65860962	1,09682803	0,20%	36	0	1,057043494	0,50%
Just coin EUR	16,65834425	25,42408333	0,50%	2	27,67	1,057043494	0,50%
Local btc EUR	29,19187798	130,6034444	1,00%	0	20,33	1,057043494	0,50%
Rock EUR	10,44144918	42,68083333	1,00%	0	28,67	1,057043494	0,50%
Local BTC GBP	35,02943341	362,6496667	1,00%	0	20,33	3,173053303	1,80%
Asia Nexgen HKD	16,78126547	464,6328056	0,15%	2	24,67	-0,07751938	3,70%
Local HKD	29,5197111	8,51052474	1,00%	24	20,33	-0,07751938	3,70%
bit2c	16,13222036	37,75911111	0,60%	0	24	1,774937877	1%
local btc INR	38,58894161	3,476854167	1,00%	17	20,33	3,726708075	8,59%

Local btc MNX	39,9402379	7,381369792	1,00%	7	20,33	1,055408971	3,50%
Justcoin NOK	12,35373252	35,76772222	0,50%	2	27,67	-0,536352801	1,80%
Local NOK	50,89098232	5,947527778	1,00%	9	20,33	-0,536352801	1,80%
bit.nz	2,399248867	26,17075	0,50%	1	17	4,505481267	1,50%
Local NZD	47,68893355	8,196902778	1,00%	4	20,33	4,505481267	1,50%
Bitcurex PLN	12,59973637	718,8789983	0,40%	8	19,67	1,912399753	0,30%
Local PLN	18,22692327	1,737736111	1,00%	39	20,33	1,912399753	0,30%
BTC-e RUB	8,925783889	404,0471111	0,20%	0	29	-8,681672026	7,60%
Local RUB	32,17379968	5,871069444	1,00%	15	20,33	-8,681672026	7,60%
FYB.se	13,6225556	23,69077778	0,80%	1	23,33	-2,031746032	-0,60%
Kapiton	14,03011322	30,8384276	1,00%	23	23,33	-2,031746032	-0,60%
Local SEK	34,4460185	4,806236111	1,00%	5	20,33	-2,031746032	-0,60%
FYB-sg	17,84054544	23,33572222	0,60%	1	27,33	-0,699650175	2,50%
Local SGD	40,87818508	4,760194444	1,00%	29	20,33	-0,699650175	2,50%
Local THB	8,255488928	18,29975	1,00%	3	20,33	-3,75	2,62%
BITX ZAR	50,29302489	12,91266667	1,00%	3	20,33	-4,618473896	6,10%
Local btc ZAR	85,47514342	7,01125	1,00%	0	20,33	-4,618473896	6,10%
Asia Nexgen USD	26,56671677	4,209218506	0,15%	56	24,67	0%	2%
BitFInex	0,950666667	14442,46844	0,40%	0	26,67	0%	2%
Bitkonan	2,610666667	5,6475	0,29%	0	17,33	0%	2%
Btc-e USD	11,03094444	19266,21444	0,20%	0	29	0%	2%
Camp BX	1,638277778	319,8404722	0,55%	1	27,33	0%	2%
Cryptotrade USD	0,138238281	13,37160786	0,20%	11	0	0%	2%
Local btc USD	56,995	440,7392778	1,00%	0	20,33	0%	2%
Rock USD	0,617333333	2,879277778	1,00%	0	29	0%	2%

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