Bibliometric analysis on the Economic approach to Bitcoins

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Abstract

The objective of this article is to identify the main characteristics of scientific research regarding the economic approach on bitcoins. This study is based on bibliometric research and network analysis, with the use of descriptive statistics in 84 articles found on the Web of Science database. The analysis used the software tools VOSviewer and Excel. The main results show that Bouri, Bouoiyour, Dyhrberg and Selmi are the authors who published the most articles and that the Université de Pau (France) and the University College Dublin (Ireland) are the institutions with the most publications. The journal with the most publications is Plos One, which presented a 3.057 impact factor. There are only three co-authoring networks with greater expressiveness, however, there are no links between them and the others. Despite the growing number of publications on the subject, research on the theme is still incipient, showing a wide field for exploration.

Keywords: Currency. Digital Currency. Cryptocurrency. Bitcoin.

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1 Introduction

Currencies have changed over the centuries; however, they were always the method used in financial transactions. Barter and precious metals used to be currencies, later and until nowadays, paper money became the most common form of currency. Generally, currencies are centralized, i.e., the central bank of each country emits and controls the currency used in its territory based on the legislation in force, the bank may change its value or fix it (Vasconcellos, 2015).

To facilitate financial transactions, a new type of currency was created in recent decades, the digital currency. As examples we can cite the miles systems of airline tickets, the loyalty system of some companies, coins used in virtual games, among other types of rewards. In addition, there is a special type of digital currency that is not centralized, which is the case of cryptocurrency.

Cryptocurrencies are a decentralized system in which the currency is controlled and protected by encryption, i.e., there is no authority or government controlling its exchanges, which causes cryptocurrencies to be virtually immune to government legislation interferences (Narayanan, Bonneau, Felten, Miller, & Goldfeder, 2016).

Digital currencies became notorious in the market, especially bitcoins, therefore, this study aims to identify the main characteristics of scientific research regarding their approach on bitcoins.

The study is structured in five sections. The first is composed by the introduction and an explanation of the subject, research problem and article structure. The second presents the theoretical framework on currency, cryptocurrency and bitcoins. The third describes the methodology used. The fourth presents the analysis and description of data. The fifth is composed by the final considerations, contributions and limitations of the study, as well as recommendations for future research.

2 Currency

A currency is an object used to materialize the labor performed on a product or service, to assign, measure and record economic value. Currencies allow us the ease of performing transactions in which everyone in a certain location uses the same form of currency. Controlling the currency in a country is strongly linked to Economics. On the one hand, the shortage of currency supply imposes severe restrictions to the real economy by inducing an economic contraction; on the other hand, an oversupply may cause an inflationary effect (Massoud, 2005).

The payment system has evolved over time and is still evolving. Silver and gold coins were used for transactions in the last century, after years using this monetary system, a system that uses paper money was developed – the currently known form – as a method of payment. Thus, society is currently

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evolving into a system that uses technological and electronic resources, which are rapidly replacing payments made by paper money (Angel, 2015).

According to information from the website WorldAtlas, in 2017, there are 129 different types of currency in circulation in 193 countries, considering the UN member countries, and for the control of currency in an economy. Friedman and Schwartz studied the theory of monetarism and pointed that the quantity of money has decision-making influence on the economic activity and on the prices. Therefore, to achieve monetary policy goals, the growth of paper money production must be regulated (Dunaev, 2012).

Friedman formulated a monetary rule that consists of gradually increasing the production of paper money, regardless of the economic situation. On the other hand, Keynes created a concept in which the State must regulate the economy, and that the economy is a self-regulatory system. Such concept was shown to be controversial by the theory of monetarism proposed by Friedman and Schwartz (Dunaev, 2012).

2.1 Cryptocurrency

To understand the bitcoin model, we must know what cryptocurrencies are, which are a subset of digital currencies, as well as one of the key concepts of bitcoin, decentralization.

Knowing some basic concepts, such as encryption and peer-to-peer networks is necessary to understand how a cryptocurrency works. Encryption is a tool that turns any data into unreadable data, and that allows the recovery of the original data if necessary (Burnett & Paine, 2002).

Peer-to-peer networks are a system of digital networks in which participants can share information and resources, the participants of this system are not distinguished and there is no need for a central organization to control the transaction (Rocha, Domingues, Callado, Souto, Silvestre, Kamienski, & Sadok, 2004).

The data in a cryptocurrency network are encrypted and represented by a public code. Users have the unique code of the coins they possess and can perform transactions if they know the public code and have their unique code (Oliveira, Totti, & Ney, 2014).

Bitcoin, the most popular and notorious cryptocurrency, was developed in 2008 (Nakamoto, 2008). Nowadays, there are several examples of cryptocurrencies, such as Zerocoin, Peercoin, Nxt, Ethereum, Dash, Decred, Factom, Ripple, among others.

2.2 Bitcoins

Satoshi Nakamoto proposed the idea of Bitcoin on the internet in 2009. The concept is an innovative alternative and a counterproposal to the current monetary system, since it seeks to be a virtual currency based on a computational code. Thus, the platform bitcoin.org – which is a community-driven project and software – allows its users to produce what they call money. The users can perform anonymous transactions with each other without using intermediary institutions (Weber, 2014).

Each Bitcoin consists of a chain of unique digital signatures that can be stored in a digital wallet that is installed on the user's computer. The digital portfolio generates keys that are used to send and/or receive coins. Thus, the transitions are performed by the owner and user of the currency, who uses a digital key to approve the addition of the receiver's key. After this process, the currency is transferred and becomes available in the receiver's portfolio with a transaction history (Bjerg, 2016).

The developers limited the stock of coins to be released for circulation to 21 million, therefore, every 10 minutes the system releases a certain number of new bitcoins on the vault. Bitcoins must be "mined", this process was inspired by gold mining. The organization of the mining process rewards nodules to the volunteers, so they can perform payment transactions between two users. The volunteers invest in computational power to join the nodules network to compete for the acquisition of newly released coins (Weber, 2014).

Bitcoin is popular because it is a currency that is not controlled by banks or governments. According to Andreas Antonopoulos, who hosts the Let's Talk Bitcoin podcast, "anyone can send money to another person in the world with a transaction fee that costs less than a dollar" (Revell, 2017).

3 Methodological Procedures

The objective of this article is to verify the representation of scientific research on bitcoins. The research is descriptive and explanatory. The primary interest of a descriptive piece of research is to discover and observe situations, describing it, as well as classifying and interpreting the data. Through descriptive research we can determine the variables that constitute the situation-problem, the similarities and differences that exist between the data, among other things. In addition, it allows the theme to be analyzed qualitatively and quantitatively, by using graphs and tables. The objective of an explanatory research is to show the relationship between the variables, checking for dependency between them and how influences from a variable affect the others, as well as studying the causes and consequences in a phenomenon (Rudio, 1992). We used the bibliometrics method to review publications and study the quantitative aspects. We also analyzed the social network for the relationships and interactions between different authors.

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Bibliometric analysis covers a large period of time and assists in the identification of important information, such as the most productive authors, most cited references, most productive educational institutions, and the individual approaches used by the authors. There are models of data analysis that follow a standard, establishing some of the bibliometrics laws. We will use the most renowned laws for this study: Bradford's law, Zipf's law and Lotka's law (Ribeiro, Antonialli, & Zambalde, 2015).

Bradford's law, also known as law of dispersion, was created to identify the scope of periodic publications about a specific subject, estimating the degree of relevance that each journal has. Journals that publish more articles about a certain subject usually present a high relevance in that specific area of knowledge. Data collected by Bradford's law show that there is a tendency to there be a small number of journals that discuss the subject extensively, and many journals that are not even included in the thematic representation services and abstracts. Bradford's law is useful due to the dissemination of information and scientific and technological knowledge. The research process of this method facilitates the work of future researchers, allowing them to search a small database of journals on a given theme, identifying several publications on the subject (Guedes & Borschiver, 2005).

Zipf's law concerns the number of times a word is repeated throughout a text. The law shows us that in relatively long texts there is an orderly relationship between the frequency of a certain word and its position in the list of recurring words of the text. The first Zipf's law regards the region of high frequency words and the second Zipf's law regards the region with low frequency words. The words of greater significance appear in the transition region between high and low frequency terms, i.e., articles, prepositions and connecting words are excluded, allowing the appropriate words for indexing to be found more easily (the action of describing a document according to its subject). Zipf's law is important as a statistical tool because it contributes to indexing automation (Guedes & Borschiver, 2005).

Lotka's law, also called inverse-square law, says that a limited number of researchers are responsible for the vast majority of production in a particular area of knowledge. In short, the law notes that in a given area of knowledge, the number of authors who produce two articles, for example, equals a quarter of all authors that publish an article. Consequently, about 60% of the authors of a field of knowledge only produce one article during their academic life. Lotka's law is useful when assessing the productivity of authors, identifying the most notorious research cores and providing the understanding that the more solidified an area of knowledge is, the greater the chance of authors producing several articles in a given period of time (Guedes & Borschiver, 2005).

Collaborations between authors are increasingly important in the contemporary world, knowledge sharing and the union among researchers when seeking personal objectives within a common theme will propel their research. Shared work offers several advantages, such as less time and resources spent, as well as greater access to databases. This encourages research funding agencies (Maia & Caregnato, 2008).

Concomitantly, it increases the interest of researchers in analyzing these co-authorships, which can function as collaboration indicators. The analysis of these indicators can check the differences between these collaborations, as well as the impact, visibility, among other things (Maia & Caregnato, 2008).

In addition to the coauthoring analyses, the law also analyzes networks: groups of people, institutions or organizations that are connected and share information with each other, creating a new scientific basis. One of the important factors to be analyzed in networks is the degree of centrality on the power an individual has on it: being in the center ensures greater opportunities and fewer restrictions (Maia & Caregnato, 2008).

We searched the data on the Web of Science database using the keyword "bitcoin*" and the filters: title, English language and scientific articles as the document type. The results were 84 documents.

We performed a new filtering considering the titles, considering those with Economics and Financial approach and excluding the area of Informatics, which was not the focus of this study.

Regarding the filtering by title, initially, at least two researchers read all 84 titles individually. We compared both screenings and in case of divergence the researchers sought a consensus. The result was 53 articles, starting from 2013 to August 2017.

Next, we used the software tools VOSviewer and Excel as tools to analyze the selected articles, considering the bibliographic data and analyzing the co-authorships based on authors, institutions and countries.

4 Analysis and discussion of the data

Table 1 presents all 53 articles ordered according to the author, impact factor (IF) of the corresponding journals, year of publication and number of citations (Ci).

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Table 1 – Selected articles

Author	IF	Year	Ci
Tschorsch and Scheuermann	9,22	2016	0
Boehme, Christin, Edelman and Moore	5,012	2015	21
Garcia, Tessone, Mavrodiev and Perony	3,818	2014	16
Kondor, Csabai, Szuele, Posfai and Vattay	3,57	2014	2
Meiklejohn, Pomarole, Jordan, Levchenko, Mccoy, Voelker and Savage	3,301	2016	0
Kondor, Posfai, Csabai and Vattay	3,057	2014	20
Chu, Nadarajah and Chan	3,057	2015	0
Kristoufek	3,057	2015	14
Donier and Bouchaud	3,057	2015	4
Li and Wang	2,604	2017	0
Delgado-Segura, Tanas, and Herrera-Joancomart	2,033	2016	0
Polasik, Piotrowska, Wisniewski, Kotkowski and Lightfoot	1,853	2016	3
Angel and McCabe	1,837	2015	3
Bariviera, Jose Basgall, Hasperue and Naiouf	1,785	2017	0
Bryans	1,782	2014	16
Bjerg	1,702	2016	2
Dwyer	1,689	2015	12
Shin	1,505	2016	0
Hill	1,505	2014	1
Weber	1,263	2016	2
Hendrickson, Hogan and Luther	1,091	2016	0
Hurlburt and Bojanova	1,067	2014	5
Brandvold, Molnar, Vagstad and Valstad	1,051	2015	5
Balcilar, Bouri, Gupta and Roubaud	0,997	2017	0
Ciaian, Rajcaniova and Kancs	0,953	2016	0
Burge	0,952	2016	0
Smit, Buekens and Du Plessis	0,939	2016	2
Pieters and Vivanco	0,826	2017	0
Carrick	0,768	2016	0
Beekman	0,605	2016	0

Nadarajah and Chu	0,603	2017	0
Cheah and Fry	0,603	2015	5
Urquhart	0,603	2016	3
Ju, Lu and Tu	0,595	2016	0
Cheung, Roca and Su	0,586	2015	8
Ciaian, Rajcaniova and Kancs	0,586	2016	6
Bouoiyour and Selmi	0,571	2015	4
Henwood	0,496	2014	1
Dyhrberg	0,48	2016	3
Dyhrberg	0,48	2016	4
Bouri, Molnar, Azzi, Roubaud and Hagfors	0,48	2017	1
Bouri, Azzi and Dyhrberg	0,46	2017	0
Yelowitz and Wilson	0,378	2015	7
Maurer, Nelms and Swartz	0,352	2013	24
Luther	0,286	2016	0
Donier and Bonart	0	2015	1
Ram, Maroun and Garnett	0	2016	1
Lischke and Fabian	0	2016	1
Bouoiyour and Selmi	0	2016	0
Hackett	0	2016	0
Gervais, Karame, Capkun and Capkun	0	2014	10
Feld, Schoenfeld and Werner	0	2016	0
Bouoiyour, Selmi, Tiwari and Olayeni	0	2016	1

Source: the authors (2018)

We can observe that the highest impact factor is 9.22 and that only eight articles (15%) are in journals that have no impact factor. The years of publication are between 2013 and 2017. The publication distribution was: 1 article was published in 2013 (1.9%) – the first year of research on Bitcoins–, 8 articles in 2014 (15.4%), 12 articles in 2015 (22.6%), 25 articles in 2016 (47.2%) and 7 articles until August 2017 (13.2%). This shows a growing interest in the subject. Table 2 presents the authors who published the most during the period under research.

Table 2 – Authors' productivity

|	Article	Journal	Year	Ci	IF
Bouoiyour	Bitcoin: a beginning of a new phase?	Economics Bulletin	2016	0	0
	What Does Bitcoin Look Like?	Annals of Economics and Finance	2015	4	0,517
	What drives Bitcoin price?	Economics Bulletin	2016	1	0
Bouri	Can volume predict Bitcoin returns and volatility? A quantiles-based approach	Economic Modelling	2017	0	0,997
	On the hedge and safe haven properties of Bitcoin: Is it really more than a diversifier?	Finance Research Letters	2017	1	0,48
	On the return-volatility relationship in the Bitcoin market around the price crash of 2013	Economics-the Open Access Open-Assessment E-Journal	2017	0	0,46
Selmi	Bitcoin: a beginning of a new phase?	Economics Bulletin	2016	0	0
	What Does Bitcoin Look Like?	Annals of Economics and Finance	2015	4	0,517
	What drives Bitcoin price?	Economics Bulletin	2016	1	0
Dyhrberg	Bitcoin, gold and the dollar - A GARCH volatility analysis	Finance Research Letters	2016	3	0,48
	Hedging capabilities of bitcoin. Is it the virtual gold?	Finance Research Letters	2016	4	0,48
	On the return-volatility relationship in the Bitcoin market around the price crash of 2013	Economics-the Open Access Open-Assessment E-Journal	2017	0	0,46

Source: the authors (2018)

Bouri, Bouoiyour, Dyhrberg and Selmi are the authors who published the most, each with three publications. We must highlight that 14 authors published 2 articles each and the others, only 1 article each. Bouri is one of the authors who published the most articles and they have high impact factor, however, his articles are recent, which results in few citations. On the other hand, Dyrhberg, who is part

of Bouri's co-authorship network, has articles with approximate impact factor smaller than those of Bouri, but with a more expressive number of citations.

Complementing Bradford's law, Figure 1 shows the journals that published the most articles on the theme.

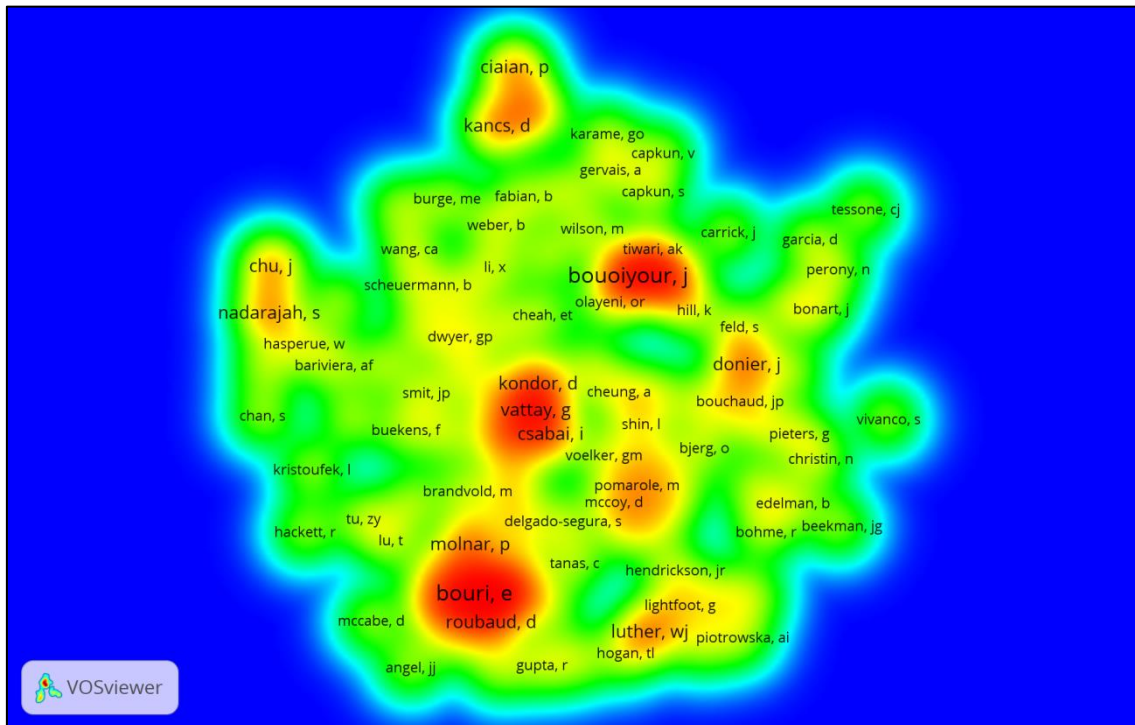Figure 1 – Journals that published the most articles on Bitcoins
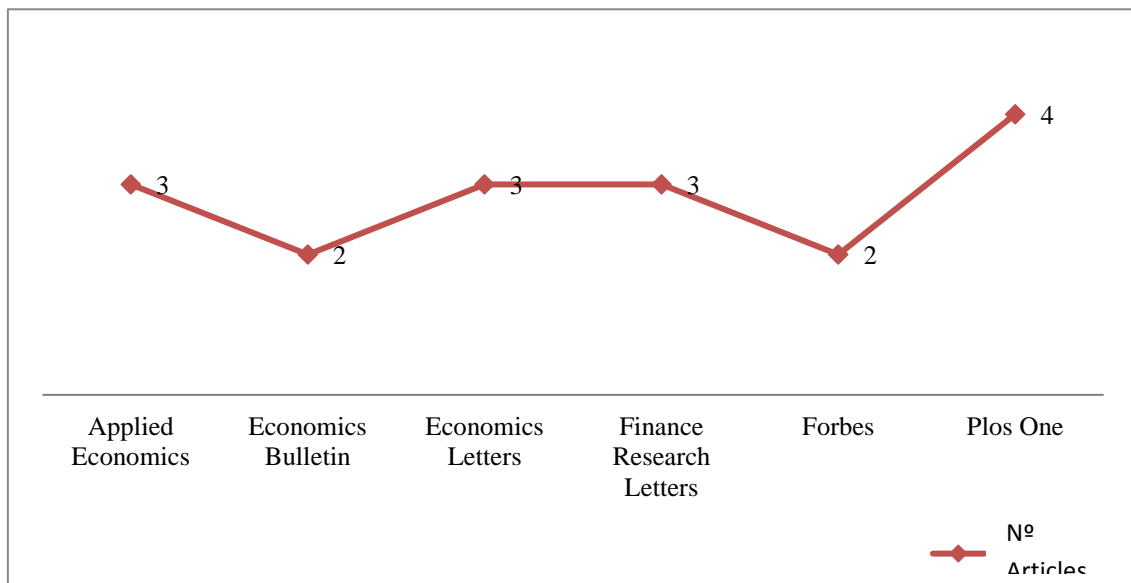
Source: the authors (2018)

Until the moment of our search, Plos One was the journal with most publications, presenting four published articles and a 3.057 impact factor. The journals Applied Economics, Economics Letters and Finance Research Letters have 3 articles each, their impact factors are 0.586, 0.603 and 0.48, respectively.

Analyzing the years of publication in the catalog of the Web of Science, we can observe that the knowledge on bitcoin is growing exponentially if we consider the number of publications. This indicates a gradual increase of studies on bitcoins.

When considering the co-authorship analysis of authors who publish the most, we identified only two networks, between Dyrhberg and Bouri and Selmi and Bouoiyour. These two networks had no connection between them, this creates distinct knowledge training centers but with great importance for Bitcoin as a theme (Figure 2).

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Figure 2 – Co-authorship networks

There are three expressive co-authorship networks. The network with greater centrality is between Csabai and Kondor, the published articles of this network have an IF greater than 3 and many citations among the community. In addition, this network is responsible for the third most cited article, "Do the Rich Get Richer? An Empirical Analysis of the Bitcoin Transaction Network", with 20 citations.

Regarding the impact factor, the greatest value (9.22) corresponds to the article "Bitcoin and beyond: a technical survey on decentralized digital currencies", published in 2016 (Figure 3). However, this article has no citations. The article "Bitcoin: Economics, Technology, and Governance" has the second greatest IF (5.012) and 21 citations. Still considering the impact factor, there are 7 articles with values between 3.057 and 3.818 (13.2%), 14 articles between 1.051 and 2.604 (26.4%), 22 articles between 0.286 and 0.997 (41.5%) and the remaining 8 (15.1%) are published in journals that are not under Journal Citation Reports (JCR).

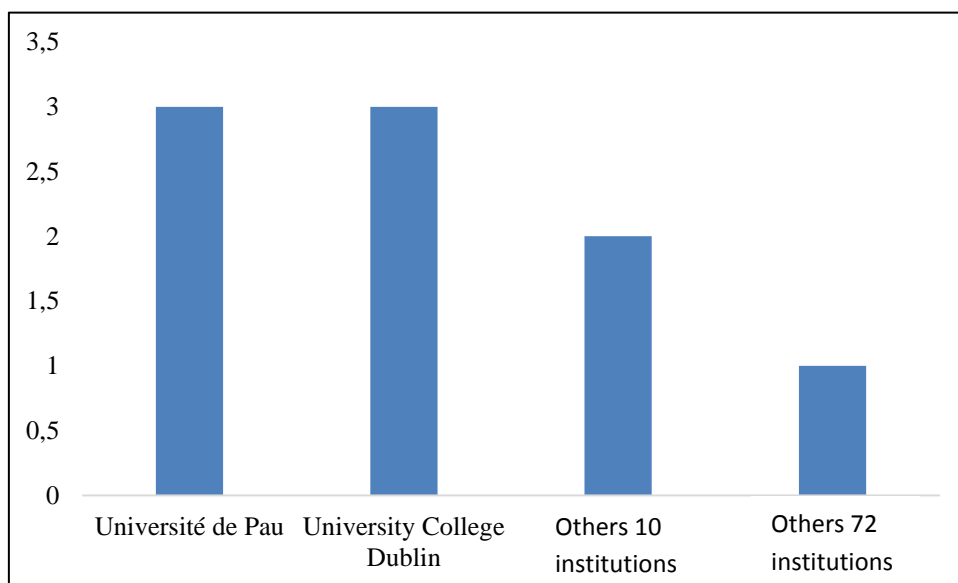Figure 3 – Impact factor of the articles
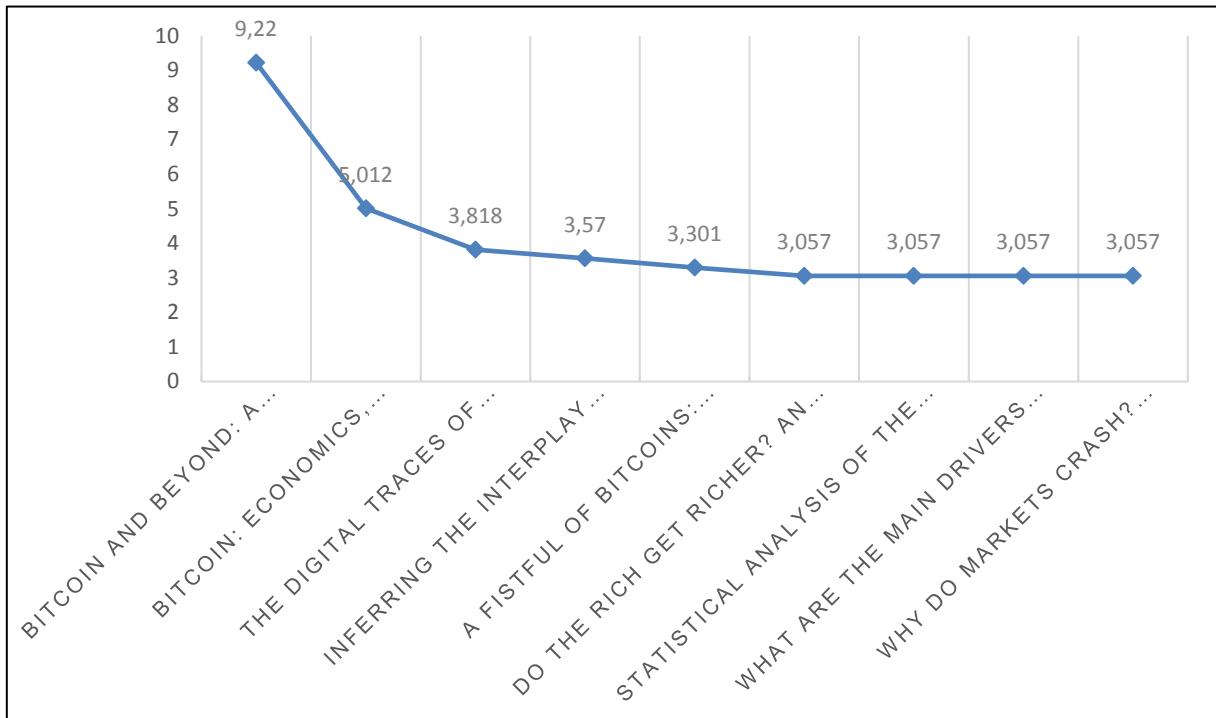
Considering the number of citations, the most cited article (24 times), "'When perhaps the real problem is money itself!': the practical materiality of Bitcoin", has a 0.352 IF, despite the large number of citations. Furthermore, the author is not part of any authorship network and has no other articles in the area.

Figure 4 shows the educational institutions that published the most articles on bitcoins until the moment of our search.

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Figure 4 – Productivity of institutions

The most relevant institutions considering the number of publications are the Université de Pau (France) and the University College Dublin. In addition, the Université de Pau is the educational institution of one of the most productive authors, Bouoiyour, and the University College Dublin is Dyhrberg's institution, who is another productive author. Figure 5 presents the most representative journals on the theme.

Figure 5 – Productivity of journals
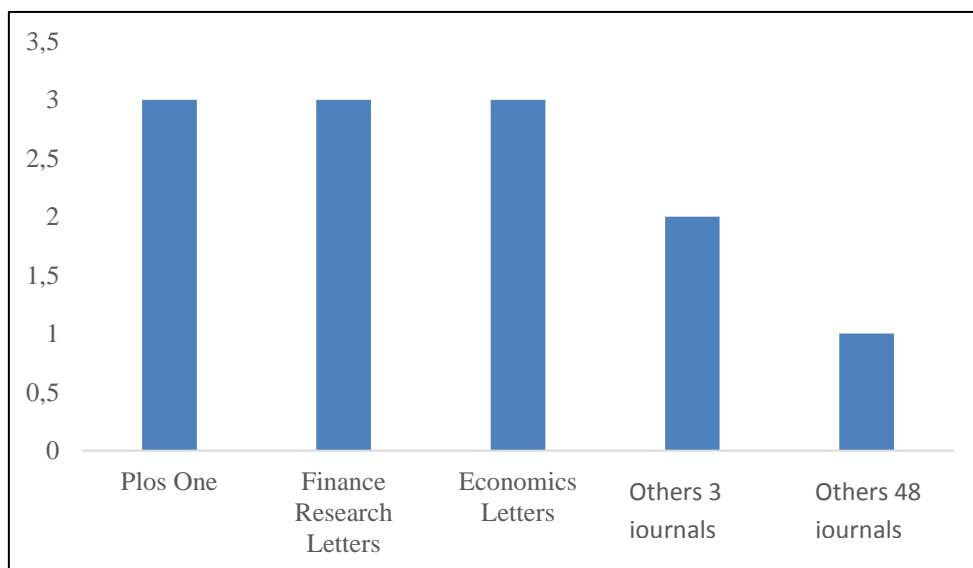
Plos One, Finance Research Letters and Economics Letters are the journals highlighted by our analysis. Plos One is not a specific journal for Economics or Information Technology, its focus is primary research in science. The other two are in Economics. Finally, we analyzed the relationship between the keywords of the articles on our database, the network is presented in Figure 6.

Figure 6 – Relationship between the keywords
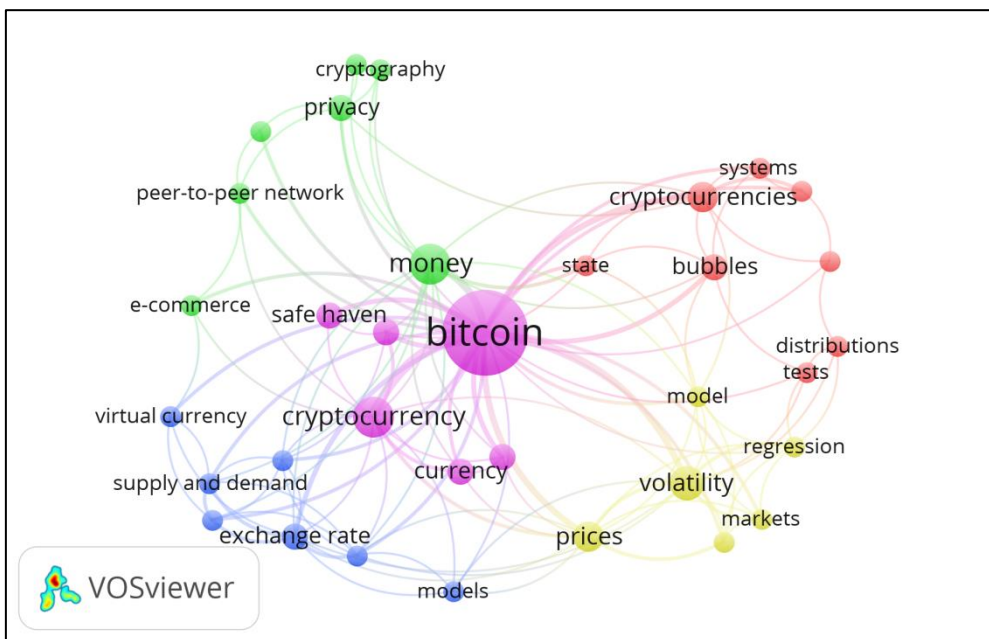
Source: the authors (2018)

"Bitcoin" is the most used keyword, other common words are "cryptocurrency", "currency", "price "and "volatility". Through the analysis of the network of keywords we can observe the existence of interrelated groups. The network represented in yellow is related to research on volatility, mathematical models of regression and on the variation of the price of bitcoins; the green network shows the computational area, thus, topics like peer-to-peer networks, privacy and encryption.

5 Final Considerations

This study investigated the scientific production of the Web of Science database, considering the period from 2013 to August 2017. For such, we analyzed 84 titles individually, through this method we identified 53 scientific articles relevant to our research. They were considered the universe where we performed two types of analysis, bibliometric and network. The focus of this research were the following criteria: author, impact factor of the corresponding journals, number of citations and year of publication.

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We highlighted the growing interest on bitcoins as a theme, due to the exponential growth in publications within the period studied. The first publication dates from 2013, in 2016 we found the greatest number of publications, corresponding to 47.2% of the productions during the period studied.

We note that during this period, the largest number of publications each author made on the theme was three, totaling 22.6% of the publications from 2013 to August 2017 by only four authors. Therefore, we understand that there is space and opportunity for more research in the area.

Regarding the citations, we highlight the author Bill Maurer. Despite not being a part of any authorship network and having no other articles in the area, he achieved the highest number of citations among the 53 scientific articles studied.

The journals with most publications on the area are: Plos One, Applied Economics, Economics Letters and Finance Research Letters, totaling 24.5% of the productions in the years studied.

Considering the co-authorship between the authors who published the most, we only identified networks between Dyrhberg and Bouri and Selmi and Bouoiyour. These networks are not connected, which creates separated knowledge production centers. Our study showed that the educational institutions that publish most articles on bitcoins during the period studied are the Université de Pau, in France, linked to the author and researcher Dyrhberg, and the University College Dublin, in Ireland, linked to the author and researcher Bouoiyour.

We can conclude that bitcoin as a scientific theme has been increasingly studied since its start in the scientific area in 2013, therefore, this article serves to understand where the concentration of publications is and who are the main authors and journals on the theme until August 2017. This creates an opportunity for researchers to develop new studies on the theme.

The number of articles analyzed can be considered a limiting factor since we only used the Web of Science database for our search. However, we used it due to the impact factor (JCR) used in the analyses.

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