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An approach to the use of cryptocurrencies in Romania using data mining technique

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Abstract. *The global economy can be regarded as a complex global adaptive system, which adapts and evolves according to the environment and the behavior of the agents existing on the market. A topic that is topical and can even affect the welfare of a country is the field of cryptocurrencies. Today, the most well-known phenomenon by people in this field is the emergence of bitcoin. Cryptocurrencies or virtual currencies are an emanation of the financial crisis that started in 2008, a crisis that had led to a decline in confidence of traditional bank. In this paper, we discussed the creation of possible speculative bubbles, we presented the virtual currencies, we applied techniques of multidimensional analysis of the data for their analysis, and we evaluated the effects that the appearance of the cryptocurrencies had on the cybernetic economic system in Romania. Also, the paper deals with a section on identifying risks in the field of cryptocurrencies. In the last part of this paper, we focus our attention on the viability of these coins and their future prospects.*

Keywords: speculative bubbles, cryptocurrencies, Bitcoin, R Studio, cybernetic systems, risk.

JEL Classification: C10, C21, C45, C63, C87, D40, E70, F18.

1. Introduction

Economics, defined as a set of economic activities, as well as science, refers, in general terms, to the need for optimal organization of limited objective resources in order to meet and balance unlimited and constantly diversifying needs. It consists of cyber and dynamic systems at both microeconomic and macroeconomic levels.

Virtual currencies explore a concept that has existed for years, namely the idea of currency digitization. For some years now, virtual currencies have exploded in popularity and are trying to produce a revolution in the way people pay.

Cryptocurrencies have aroused a cultural as well as an economic movement, and effects have also been produced politically, discussing the impact that technology will have on the world, but also the process of legalization and regulation.

Virtual currencies or cryptocurrencies are the blood that irrigates the unseen arteries of decentralized electronic payment systems, systems that have become known and functional due to the emergence of what is known today as Bitcoin.

Digital currencies appeared before Bitcoin, computer game enthusiasts, like Second Life or World Craft using such coins. Also, online trading platforms have tried to launch virtual currencies, but only their customers used in relationships with the seller. This alternative to the traditional payment system is due in part to the success of the financial crisis that rocked the world of finance at the end of 2007 and the beginning of 2008. The decentralized systems are not under the control of the monetary authorities, they do not use the traditional intermediaries, functioning exclusively due to the trust that their users invest in them. In fact, these are electronic payment systems that are based on cryptographic evidence that allow both parties to trade directly without going through the approval of an intermediary.

Decentralized systems use cryptocurrencies, virtual currencies based on cryptographic principles. The users' trust in these payment systems is based on the cryptographically validated transaction log, created and maintained by all users of the virtual currency. This paper aims to carry out an analysis both at the theoretical level by studying the history of the appearance of virtual currencies and the conceptual dimensions regarding the first 10 cryptocurrencies, as well as at the analytical level by using the statistical modeling tools or the analysis of cybernetic systems. The main objectives of the research are to improve the level of knowledge on this concept, to analyze the economic system in Romania compared to other economic systems from the perspective of regulating virtual currencies, analyzing their price volatility, statistical analysis and representation of the cryptocurrency cybernetic networks and drawing relevant conclusions.

2. Analytical study on the appearance of digital currencies

A cryptocurrency is a digital asset whose purpose is to act as a trading medium that uses powerful and complex cryptographic algorithms to secure financial transactions, control the issuance of additional units and verify asset transfers. Unlike centralized systems used by banks, cryptocurrencies use a decentralized control mechanism.

The decentralized control device of each cryptocurrency works based on a distributed registry, usually a growing list of registrations, called a blockchain, which serves as a public database of financial transactions.

In 1983, American cryptographer David Chaum developed a type of cryptocurrency which he called ecash. Later, in 1995, it implemented it with the help of Digicash, an early form of electronic payment by virtual currencies that required a software component installed on the user's computer in order to withdraw banknotes and assign certain encryption keys before being sent to the recipient. This has enabled the digital currency to be impossible to track by the issuing bank, government or any other third party.

In 1996, the National Security Agency of the United States of America launched a publication entitled "How to Make a Mint: the Cryptography of Anonymous Electronic Cash", which describes a cryptocurrency system and was first published in a mailing list from Massachusetts Institute of Technology (Laurie et al., 2016).

In 1998, Wei Dai published a presentation of b-money, described as an anonymous and distributed electronic payment system. Shortly after, Nick Szabo brought to the public the attention of bit gold, categorized as a system of electronic currencies that asked users to solve a proof-of-work function, a consensus mechanism that is linked to a fundamental problem of distributed computing, and multiagent systems. The purpose of this problem is to obtain the general reliability of the system in the presence of a certain number of defective processes. Proof-of-work rejects computer attacks or other abusive actions, such as spamming a network through the need to perform certain steps by the requester, which usually results in a processing time performed by the computer.

The first virtual currency, bitcoin, was created in 2009 by the so-called developer or group of programmers Satoshi Nakamoto, whose identity has remained undisclosed to date. It uses the SHA-256 hash encryption feature set, present in many security applications and protocols, as a proof-of-work mechanism. Shortly, in 2011, Name coin cryptocurrency was created, aimed at eliminating internet censorship by implementing a decentralized domain name system (DNS).

Litecoin currency appeared in the same period. Unlike bitcoin, it uses the script mechanism, derived from the original SHA-256 algorithm, which resulted in trading speeds about 75% higher than in the case of bitcoin. After the emergence of Litecoin, several alternative currencies, called suggestive altcoins, were created further.

At the end of 2011, the proof-of-stake concept was introduced, which implies that a user can create new units from a certain cryptocurrency directly in proportion to the amount already held by it. Compared to proof-of-work, this concept is not based on the mining process, so it does not require a certain computational power from the computer system. In 2012, the first virtual currency using a hybrid based on the proof-of-work and proof-of-stake systems, called Peercoin.

As for alternative uses, bitcoin was a widely used means of trading in the digital black market Silk Road, which ran from 2011 to 2013. Specifically, bitcoin was the only accepted payment method, being difficult to track by government authorities and semi-anonymity,

compared to other means of payment. Thus, total sales of about $ 1 billion were recorded on Silk Road. Also, for these transactions, the users used dark wallets, alternative wallets for cryptocurrencies that offer additional layers of protection, as opposed to the classical ones, used for most transfer operations.

The year 2013 proved to be a truly disruptive one in terms of cryptocurrency evolution. Blockchain technology, on which cryptocurrencies such as bitcoin, Litecoin or Ripple are based, has been oversubscribed due to the unusually large number of transactions conducted in that period as a result of growing popularity and mass adoption and partly because bitcoin has reached value from $ 998. Thus, the virtual currency exchange platform Mt. Gox, one of the most important players in the industry at that time, briefly stopped deposits in bitcoin.

In 2015 there were several technological advances in the field of blockchain. Also, this period gave rise to several virtual currencies, one of the most important being Ether, based on the distributed computing platform Ethereum. Thus, there was a real impact on the cryptocurrency market.

The most popularized period in the history of bitcoin was 2017. After a glaring rise from $ 998 on January 1, 2017 to $ 19,783.06, the highest value ever reached, on December 17, 2017, the Chinese government began to warn the population. It's about the occurrence of a speculative bubble caused by this unexpected growth. Moreover, China imposed a total restriction on bitcoin trading on February 1, 2018. Since 2018, the price of bitcoin has been steadily declining, and 2019 started with a trading rate of $ 3747/bitcoin, with 81% less than its highest value, recorded at the end of 2017.

Intercontinental Exchange, the entity that holds the New York Stock Exchange, has made available for trading futures contracts on bitcoin on its exchange platform, called Bakkt. Bakkt also announced that it will launch options trading on bitcoin in December 2019. However, losses caused by the decline in the value of virtual currencies have had a major impact, and population confidence in the cryptocurrency market has declined enormously. That said, the cryptocurrency market has continued to fluctuate, but slightly lower and has never reached historical highs, as in 2017.

Figure 1. *Timeline of cryptocurrencies occurring 2008-2017*[(1)]

Source: Cryptocurrencies and blockchain, European Parliament, 2018, http://www.europarl.europa.eu/cmsdata/150761/TAX3%20Study%20on%20cryptocurrencies%20and%20blockchain.pdf

3. Literature review and mathematical models

An important aspect in an investor's decision to invest in a cryptocurrency portfolio is the existence or occurrence of a price bubble or a speculative bubble. Thus, research and identification of these bubbles must remain a topic of great interest. The statistical tools that have been developed for the testing of financial bubbles have been applied quite recently in cryptocurrencies and are generally used to detect one or more bubbles; one of the differences between the two types of tests is the change of the time window. The first study that was conducted was that of MacDonell (2014) who investigated the existence of a price bubble in Bitcoin using the LPPL (Log Periodic Power Law) methodology proposed by Johansen et al. (2000), as well as by Sornette (2003).

One of the ideas that the authors have developed is that market agents are of two types: agents with rational expectations and agents with behavior influenced by what most agents do, imitative behavior. Conditions in a normal market are characterized by disorder and a lack of behavioral similarity. The authors consider that when agents form groups with similar and organized behaviors, a bubble is formed through the interactions of the agents and the increase of risk.

Using the LPPL model, the expected value of the logarithm of the price of an asset when it is on the rising trend due to a price bubble is:

$$E[lnp(t)] = A + B(t_c - t)^{\beta} + C(t_c - t)^{\beta} \cdot \cos\left[\omega ln(t_c - t) - \phi\right]$$

where ω represents frequency of oscillations in a bubble, t_c is the critical time from the end of a bubble, A > 0 is the value $lnp(t)$ at the critical moment of time t_c, B < 0 increase $lnp(t)$ before the critical moments t_c, C $\neq$ 0 is the proportional magnitude of the oscillations around the exponential growth, $0 < \beta < 1$ represents the power of accelerating prices, iar $0 < \phi < 2\pi$ is a phase parameter.

The conditions for a positive price bubble to be realized are the following:

- $\beta \in (0,1)$
- The rate of collapse of the price, according to van Bothmer and Meister (2003), should be:

$$b = -B\beta - |C|\sqrt{\beta^2 + \omega^2}$$

- Lin et al. (2014) added a third condition according to which residuals the equation of expectation on the logarithm of the price to be stationary.

MacDonell (2014) used the LPPL model to predict the price bubble burst of December 4, 2013, showing the utility of these models for detecting price bubbles within cryptocurrencies. In order to detect multiple price bubbles, in the following we will present several methods, of which we will also choose the applicative study.

One method that is based on the one mentioned earlier is that of the "Didier Sornette" (DS) confidence indicators abbreviated in the DS-LPPLS specialty literature proposed by Sornette et al. (2015). The authors extend the LLPLS method starting from the study of Filimonov and Sornette (2013).

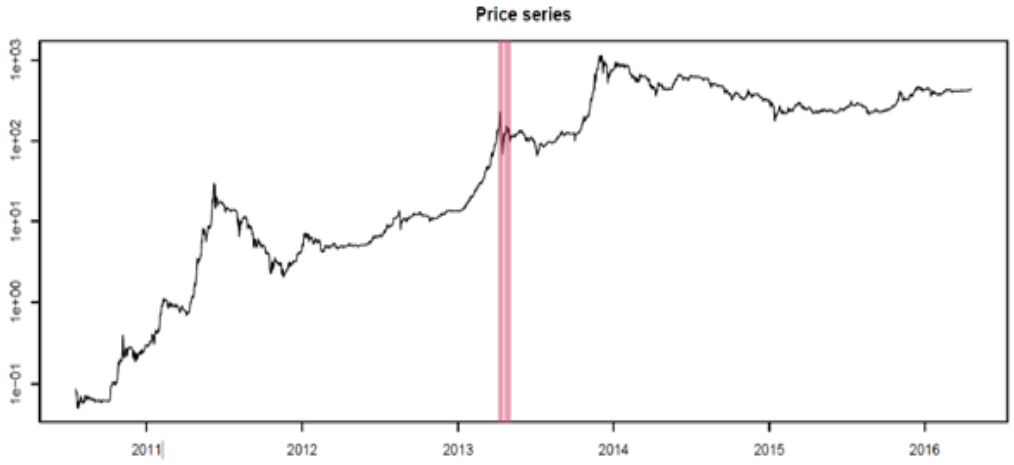
A point is set at time t2, and the time series is captured in periods (t1, t2) whose periods dt = t2-t1 decrease successively from 750 days to 125 days, point t1 changing in steps of 5 days.

The total time segments with the ends t1 and t2 are of a total of 126. Then, a series of conditions and search intervals are applied on the parameters of the model that we illustrated in the table below. Only the LPPL models that satisfy these conditions are considered and estimated to be valid. Then, from the LPPL models considered valid, two other indicators are calculated: the DS LPPLS trust indicator and the DS LPPLS trust indicator.

Table 1. *Filter and search range conditions for choosing LLPL models according to Sornette et al. (2015)*

Appearance	Notation	Search range	The first filtration condition	Second filtration condition
Acceleration	β	[0,2]	[0.01,1.2]	[0.01,0.99]
Nonlinearity	ω	[1,50]	[2.25]	[2.25]
Parameters	t_c	$[t_2 - 0.2dt, t_2 + 0.2dt]$	$[t_2 - 0.05dt, t_2 + 0.1dt]$	$[t_2 - 0.05dt, t_2 + 0.1dt]$
Oscillation	$(\frac{\omega}{2\pi})\ln[\frac{\lvert t_c - t_1\rvert}{\lvert t_c - t_2\rvert}]$	-	[2.5,+∞)	[2.5,+∞)
Dumping	$\frac{\beta}{\omega}\frac{\lvert B\rvert}{\lvert C\rvert}$	-	[0.8, +∞)	[1, +∞)
Relative error	$\frac{p_{t-\hat{p}_t}}{\hat{p}_t}$	-	[0,0.05]	[0,0.02]

Figure 2. *Evolution of the price of Bitcoin and the detection of a bubble (pink area) by the DS-LPPLS test applying the filtering conditions used by Sornette et al. (2015) and Fantazzini (2016).*



It can be seen that the test detected 2 bubbles where in the first third of 2013, indicated by the pink areas, while, using different filtering conditions, the results showed that there were more bubbles starting with the last third of 2013 until about the first third of 2014. It should be noted that the results are not very accurate as there were only 5 estimation windows for simplification. For the best accuracy, 126 estimation windows are recommended, but the calculation is far too complex for an ordinary computer.

Ceah and Fry (2015) also tested the existence of multiple price bubbles using a test proposed by Fry (2014), detecting the presence of a price bubble in the case of Bitcoin. Ceah and Fry (2015) assumed the following equations:

$P(t) = P(t)(1-k)^{j(t)}$
where

$$dP_{1^{(t)}} = \left[\mu(t) + \frac{\sigma^2(t)}{2}\right] P_{1^{(t)}} dt + \sigma(t) P_{1^{(t)}} dW_t$$

where W_t is a Weiner type process, and $j(t)$ is a type process:

$$j(t) = \begin{cases} 0\,, before\ the\ bubble\ burst \\ 1\,, \quad after\ the\ bubble\ burst \end{cases}$$

and k represents the loss expressed as a percentage of the asset after the price bubble burst. Before the break, we have $P(t) = P_1(t)$ and, using Ito theoreme, the authors showed that $X_t = \log(P(t))$ satisfy:

$dX_t = \mu(t)dt + \sigma(t)dW_t - vdj(t),$

$v = -\ln[(1-k)] > 0$

4. Data analysis in R, results and discussion

Usually, bitcoin (BTC) is described as a virtual, decentralized, and (at first glance) anonymous currency that is not backed by the government or supported by any other legal entity and cannot be exchanged for gold or any other commodity. Bitcoin can be bought with and converted directly into fiat currency within a wide range of cryptocurrency exchange platforms (for example, Coinbase, Kraken, Coinflux, etc.).

Of all the cryptocurrencies currently in circulation, bitcoin is one of the easiest currencies to convert to fiat currency. Bitcoin is accepted as a legitimate source of funds by a relatively large number of traders (online), including various large companies (i.e. Microsoft, Playboy, LOT Polish Airlines, etc.). As a result, it can be qualified as a medium of exchange.

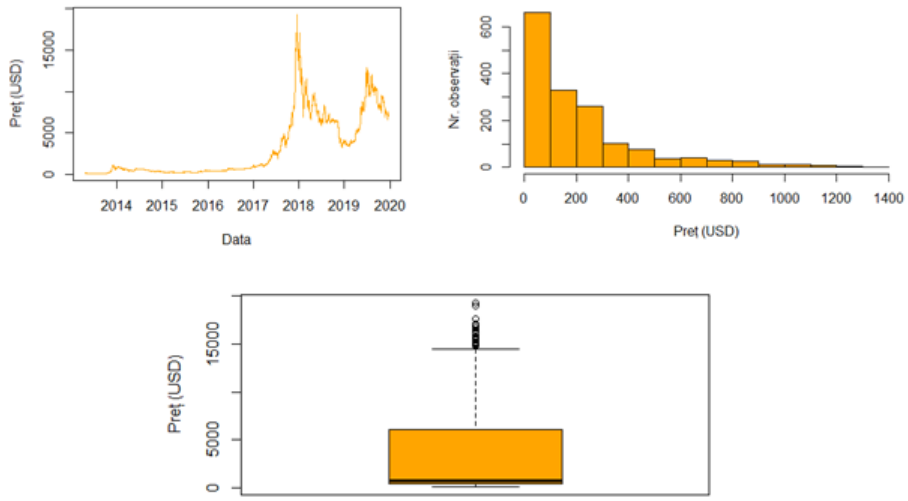
Following the analysis of the evolution of the Bitcoin price during the period 23.04.2013-23.12.2019, the following results were obtained:

- Average = $ 3037.51 / BTC;
- Median = $ 704.32 / BTC;
- Standard deviation = $ 3748.21 / BTC.

The standard deviation far exceeds the value of the average, with Bitcoin being highly volatile, a thing commonly found in virtual currencies. The coefficient of variation has a value of well over 35%, indicating that the value of the average is not representative in Bitcoin analysis. The distribution has asymmetry to the right, which is due to the relatively low prices mainly recorded during this period. The existence of high value outliers is

observed during the period studied. These values were recorded in the period 07.12.2018-10.01.2019, a period in which the historical maximum of almost USD 20,000 was reached.

Figure 3. *The evolution, histogram and boxplot of the Bitcoin price in the period 23.04.2013 – 23.12.2019*

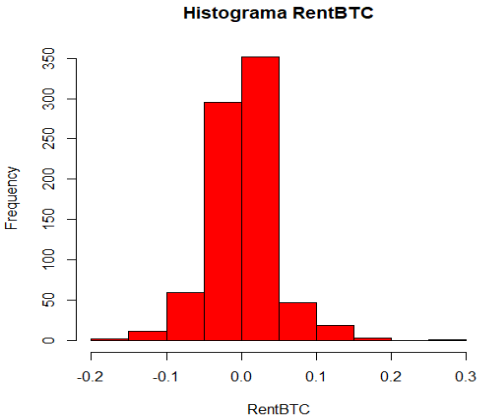


Source: Authors' own research results.

Research from the University of Cambridge estimates that in 2017, there were 2.9 to 5.8 million unique users using a cryptocurrency wallet, most using bitcoin. Bitcoin has been criticized for its use in illegal transactions, high electricity consumption, price volatility and exchange theft. Some economists, including several Nobel laureates, have characterized it as a speculative bubble. Bitcoin has also been used as an investment, although several regulatory agencies have issued warnings to investors about bitcoin.

Regarding the returns of BTC cryptocurrencies, a minimum of -16.85% was registered on 16.01.2018, and a maximum of 25.24% on 07.12.2017. The average return is 0.159% and the standard deviation is 0.04. The coefficient of variation is 2686%, so we have to deal with very large changes, inhomogeneous data, and the data set is not representative.

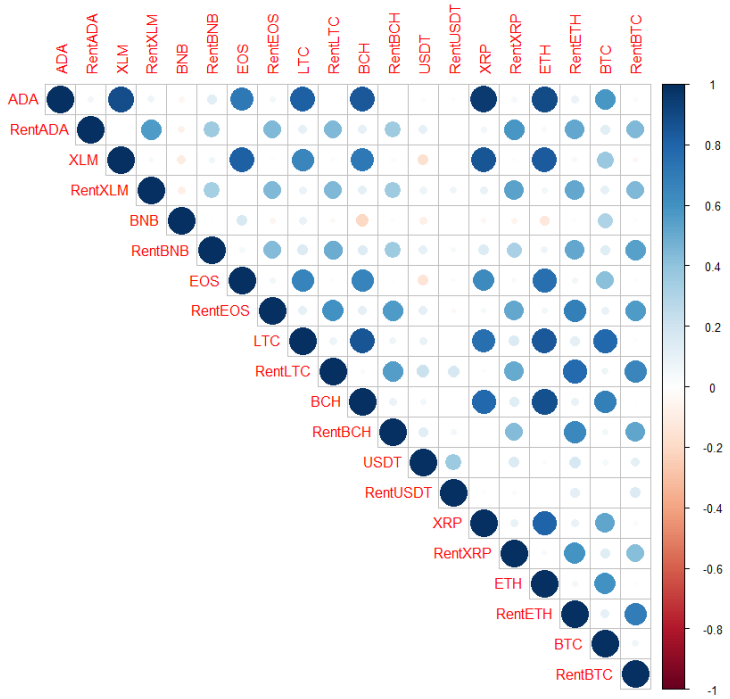
Figure 4. *Dailey return of Bitcoin*



Source: Authors' own research results.

From the above histogram but also from the calculation of the asymmetry coefficients (= 0.38) and vaulting (= 6.67), we have a slightly asymmetrical distribution of returns to the right, and pronounced leptokurtic. Values are highly dispersed, with obvious fluctuations of large and small values.

Figure 5. *Matrix of the correlations of the closing prices of the analyzed shares and their returns*



Source: Authors' own research results.

We observe with darker shades the strong correlation between the prices of Cardano cryptocurrencies compared to Ripple and Etherum, and between Bitcoin Cash and Etherum, these being just a few examples. As the shades are less pronounced we identify independent behaviors of the cryptocurrencies observable due to the weak correlation.

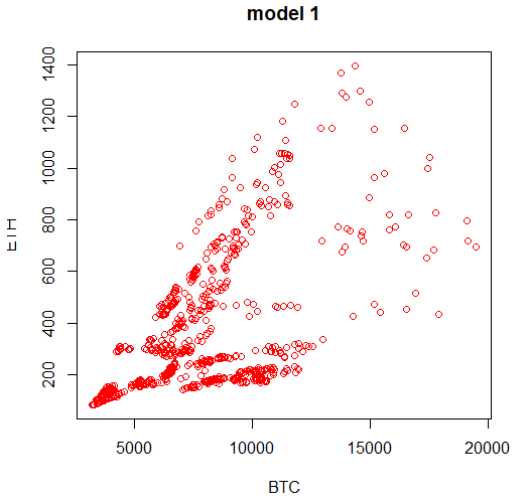
Figure 6. *BTC ETH regression model*

```
Call:
lm(formula = BTC ~ ETH)

Residuals:
    Min      1Q  Median      3Q     Max
-3306.3 -1877.2  -631.5  1540.3  9602.6

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 5282.8429   142.4856   37.08   <2e-16 ***
ETH            6.9387     0.3265   21.25   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2366 on 789 degrees of freedom
Multiple R-squared:  0.364,     Adjusted R-squared:  0.3632
F-statistic: 451.6 on 1 and 789 DF,  p-value: < 2.2e-16
```

Source: Authors' own research results.

The model equation is: BTC = B0 + B1 * ETH meaning BTC = 5282.8429 + 6.9387 * ETH. The coefficient B1 shows us by its positive value that the connection between the 2 variables is a direct one. Thus, an increase in the ETH price would inevitably lead to a BTC price increase. Specifically, a 1 percent increase in ETH would increase BTC's share by 6%. We notice that the free term is statistically significant (p-value <0.05 & ***) but this does not matter much. Note: the ETH coefficient is significant (p-value <0.05 & ***). The coefficient of determination (R-squared = 0.3632) shows that 36% of the BTC variation is due to the ETH variation.

Figure 7. *Graphical representation of the BTC ~ ETH model*



Source: Authors' own research results.

Analyzing the graph confirms the dependence between the two variables, we can draw a representative line through which we can see a direct connection between the evolution of the 2 prices of cryptocurrencies Bitcoin and Etherum.

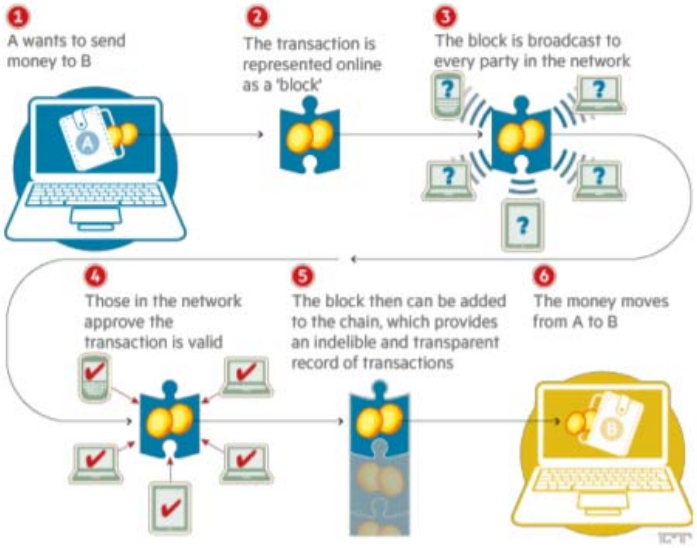
4.1. Risk analysis regarding the use of virtual currencies

In order to be able to identify and understand the risks of using cryptocurrencies, we must first understand how it works (Chiriță and Nica, 2019). Cryptocurrencies are based on a platform called blockchain. This is a digital, decentralized and public counter for all virtual currency transactions. A transaction is called a block. Complete blocks are recorded and added chronologically in the blockchain, allowing users to keep track of all transactions, without the need for a central record. Each node, meaning a computer connected to the network, receives a copy of the blockchain.

This platform has the following characteristics:

- It is irreversible, meaning a transaction cannot be canceled.
- It is anonymous, the accounts used for the transactions being encrypted.
- It has an extremely high transaction speed, almost immediately.
- It is secure, strongly encrypted, making it impossible to break it.

Figure 8. *How a blockchain works*



Source: Technology: Banks seeks the key to blockchain, J. Wild, M. Arnold and P. Stafford, 1 November 2015, Financial Times, https://www.ft.com/content/eb1f8256-7b4b-11e5-a1fe-567b37f80b64?segid=0100320#axzz3qK4rCVQP

Risk of human error (r6)

Cryptocurrencies worth more than $ 300m were lost following a series of bugs in a popular Digital Wallet service that led to a developer accidentally taking control and then blocking funds.(2)

Cybernetic risk (r1)

Cyber risk usually refers to any risk of financial loss, disruption or deterioration of an organization's reputation as a result of the failure of its information technology systems. Cyber risk could materialize in a variety of ways such as:

- Deliberate and unauthorized breaches of security to gain access to information systems.
- Unintentional or accidental breaches of security.
- Operational IT risks due to factors such as poor system integrity.

Business risk (r2)

Cryptocurrencies are not supported by a central bank or any national or international organization. Their value is determined strictly by the value that market participants attribute through transactions. Decreased consumer confidence may cause a collapse of trading activities but also a sharp decline in the value of cryptocurrencies.

Operational risk (r3)

Due to the irreversible nature of the platform, accidental transactions cannot be canceled, as they are permanently registered in the blockchain. Also, in case of losing the access key to the virtual deposit, it cannot be replaced and the access to the deposit is permanently lost.

Regulatory risk (r4)

Some countries may prohibit the use of cryptocurrencies because the transactions violate anti-money laundering laws. Due to the large number of users and the complexity of the network, there is no way to combat money laundering.

Market risk (r5)

Due to accepting the limitation of cryptocurrencies, but also the lack of alternatives, the currency may seem more volatile than other physical currencies, being fueled by speculative demand and aggravated by hoarding.

Risk of developing illegal activities (r7)

Customers' personal data are private. Personal data is not associated with transactions.

Figure 9. *Probability impact matrix*

Risk matrix			Impact				
			Very low	Low	Moderate	Big	Very big
			1	2	4	8	16
Probability	Very low	1	1	3	4	8	16
	Low	2	2 R3	4	8 R6, R7	16	32
	Moderate	3	3	6	12	24 R5	48 R1
	Big	4	4	8	16 R2	32 R4	64
	Very big	5	5	10	20	40	80

Source: Authors' own research results: The above probabilities are established by authors based on historical events.

In conclusion, the operational risk is considered a minor risk, the business risk, the occurrence of a human error and the development of an illegal activity are considered medium risks, and the cyber risk, the market risk and the regulatory risk fall into the high risk category. These 3 types of risk are high because they have both a high probability of occurrence and a major impact so that they can endanger the activity of cryptocurrency users.

Cryptocurrencies are in Romania, as in the rest of the European Union, from a legal point of view in the gray area, that is the border between regulated and unregulated. On February 6, 2018, the NBR announced that it discourages any involvement of local credit institutions in the cryptocurrency sector due to the reputational risk. The bank also reminded of the

major risk of losing the money invested in cryptocurrencies. Subsequent to this announcement, banks announced the closure of accounts of several transactions with cryptocurrencies. In March 2018, the National Agency for Tax Administration announced that any income resulting from transactions with cryptocurrencies is taxable.

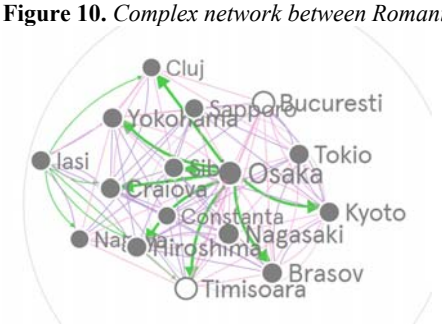
However, according to a study conducted on the global platform for cryptocurrency transactions, the Lunoun of ten Romanians, representing 9% of the total number of Romanians who have responded, owns a cryptocurrency. The 3 cryptocurrencies owned by Romanians are Bitcoin, owned by 72% of respondents, Ethereum, owned by 29% and Ripple, owned by 14%. Regarding the use of cryptocurrencies, the majority of the surveyed Romanians, accounting for 68%, said they considered them an investment, while 23% said they used them to make online payments. The remaining 7% of the surveyed Romanians stated that they use virtual currencies to transfer money to relatives or friends.

From the point of view of virtual currency security, Romanians are skeptical. Only 38% of the respondents consider cryptocurrencies as a safe investment, the rest being uncertain about the security of the coins. From the point of view of the level of interest by regions, the greatest interest for cryptocurrencies was shown by the Bucharest Municipality, followed by the counties of Bacau, Prahova and Sibiu. At the opposite pole are the counties with the lowest level of interest for virtual currencies: Galati, Mureș and Dâmbovița.

Compared to Romania, cryptocurrency transactions in Japan are regulated. The law on payment services was amended in June 2016 and entered into force on April 1, 2017. This law defines cryptocurrency as the value of the property that can be used as payment for the purchase or rental of goods or the provision of services by unspecified persons, which can be purchased or sold by unspecified persons and which is transferable through an electronic data processing system.

Japan has the world's most progressive regulatory climate for cryptocurrencies, and as of April 2017, recognizes Bitcoin and other digital currencies as a legal means of payment under the Payment Services Act. Japan is the world's largest market for Bitcoin, and in December 2017, the National Tax Agency ruled that all cryptocurrency earnings were classified as “miscellaneous revenue”, and investors taxed at rates of 15-55%. Japanese banks plan to introduce digital currency ready for the 2020 Tokyo Olympics in response to the threat posed by Chinese giant Alibaba, which recently launched its mobile payment service in the country, reports the Financial Times.

Figure 10. *Complex network between Romania – Japan*



Source: Authors’ own research results.

In the figure above we have created a complex network between 8 cities in Romania and 8 cities in Japan. Each arc represents a term that was searched on Google trends as follows:

|||||||||| → Search by "cryptocurrency";

|||||||||| → Search by "etherum";

|||||||||| → Search by "bitcoin".

The thickness of the arches shows the power of the connection established between 2 cities depending on the search terms.

5. Conclusions

Based on the analyzes presented, we consider that the cryptocurrency market is a large and volatile one. Every day new cryptocurrencies appear, others disappear, and early investors become wealthy.

The importance of multidimensional data analysis techniques is obvious in order to process sensitive information about cryptocurrencies. More and more researchers are analyzing these currencies through different mathematical models and data mining techniques make it easy to build the data framework needed for such analyzes. Speculative bubbles are important to analyze in any financial network and beyond. We have historical examples of speculative bubbles that led to the emergence of systemic shocks that spread contagiously in the respective network and led to economic crises.

One such bubble we remember is the speculative bubble of the tulip bulbs. This speculative bubble of the seventeenth century was represented by the fact that the tulip reached a price several times higher than that of the market.

Cryptocurrencies gain legitimacy as a protocol for commercial transactions, microplates and outperform popular payment instruments.

People around the world are buying Bitcoin to protect themselves from the devaluation of the national currency. In most of Asia, there is a lively market for Bitcoin remittances, and Bitcoin that uses cybercrime darkness is flourishing. More and more companies are discovering their power and adopting this emerging technology.

Institutional investors are starting to buy cryptocurrencies. Banks and governments realize that this invention has the potential to limit their control over the financial market.

Cryptocurrencies as a whole will never disappear will grow in use and acceptance as they mature.

The revolution is already happening.

Notes

(1) https://blogs.cfainstitute.org/investor/2018/04/03/cryptocurrencies-the-rise-of-decentralized-money/

(2) https://www.theguardian.com/technology/2017/nov/08/cryptocurrency-300m-dollars-stolen-bug-ether

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