“Cryptocurrencies – problems of the high-risk instrument definition”

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CRYPTOCURRENCIES – PROBLEMS OF THE HIGH-RISK INSTRUMENT DEFINITION

Abstract

Money is a widely accepted commodity, which enables us to determine the economic value of purchased goods and services and make payments. The dynamic development of technology and social expectations has expanded the spectrum of available types of payment instruments, including e-money and cryptocurrencies. Among dematerialized means of payment, cryptocurrencies began to play an important role due to their independence from central financial institutions and a highly effective form of saving money. The paper aims to present legal authorization, referring to cryptocurrencies, in countries of the European Union and prove that bitcoin is a high-risky financial instrument. The methodology of the study was based on the review of available legal acts and literature (regarding the nature and function of money) and Value at Risk (VaR) model on the example of risk assessment of cryptocurrencies with respect to investing in the selected currencies. The outcomes showed several discrepancies in the definition of cryptocurrencies. They indicated that bitcoin, as one of the best-known cryptocurrencies, does not fulfill the functions of money formulated in economic theory (in relation to e-money). Besides, cryptocurrencies have been shown to be high-risky instruments.

Keywords bitcoin, cryptocurrencies, e-money, e-market, regulation, payment systems, VaR, investing, volatility

JEL Classification E41, E42

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INTRODUCTION

The global technology development, globalization processes, increased technology availability can be considered as one of the accelerators of change in the area of payment systems. Against this background, legal processes concerning legal admission to use various electronic payment instruments and means of payment have become a necessity.

The technology and social expectations have expanded the spectrum of available types of money (dematerialized money has gained special importance), instruments, payment channels, including mobile payments and e-money, that are widely discussed in literature. The presence of cryptocurrencies in socio-economic space is becoming more and more common (Natarajan, Krause, & Gradstein, 2017). Attention was drawn to the fact that the financial sector is undergoing a major transformation brought about by the globalization processes, high technology, growing social needs. The cryptocurrencies growing popularity goes hand in hand with the complexity of the phenomena they represent, and the lack of unambiguous coherent definitions and legal regulations regarding their understanding. The cited literature presents the position of, among others, central financial institutions related to how to interpret cryptocurrencies as an example of dematerialized means of payment (European Central Bank, 2012; International Monetary Fund, 2016; National Bank of Poland, 2017). Key research is conducted in the area of whether cryptocurrencies meet the definitive assumptions of fiat money.

This paper aims to present the way the e-money and cryptocurrencies are interpreted by key financial institutions, e.g., the European Central Bank, the Bank for International Settlements in Basel, or bodies of the European Union. Legal acts were analyzed regarding the understanding of cryptocurrencies and e-money in relation to fiat money. The paper deals with one example of change, which is a natural consequence of the transformation process currently taking place in the area of payment systems – money dematerialization. It was emphasized that while e-money does not create big definition and interpretation problems, cryptocurrency already does. To analyze the risk associated with investing in cryptocurrencies, the Value at Risk (VaR) method was used – the standard measure that financial analysts use to quantify market risk. It is defined as the maximum potential loss in the value of a portfolio of financial instruments (e.g., cryptocurrencies, currencies) with a given probability over a certain horizon. The reference point for the analysis was quotations of the selected currencies (USD/PLN, AUD/PLN, CAD/PLN, EUR/PLN, HUF/PLN, CHF/PLN, GBP/PLN).

The contribution of the paper is an explanation, based on applicable legal acts of key financial institutions, that despite the growing popularity of cryptocurrencies and often equating them to money they do not meet the definition of both e-money and money in general.

1. THEORETICAL BASIS

In the study, reference was made to the assumptions of the general theory of employment, interest, and money, as indicated by Keynes (1956). How fiat money is defined (Dourado & Brito, 2014) and the functions of money and monetary capital were briefly characterized (Marchewka, 2001). Against this background, the electronic money understanding by central financial institutions was presented (The European Parliament and the Council of the European Union, 2000; Act of August 19, 2011 on Payment Services).

Then, the discussion focused on how by central financial institutions define cryptocurrencies. Definitions cited include European Central Bank (2012, 2015), International Monetary Fund (2016), Financial Action Task Force (FATF) (2014 Bank for International Settlements, Committee on Payments and Market Infrastructures (2015), National Bank of Poland (2017). Attention was also paid to cryptocurrency volatility.

Michalik (2012) also defines whether Bitcoin is an ingenious form of the financial pyramid. Facts related to volatility cryptocurrency (Vejačka, 2014), as well as benefits, including greater speed and efficiency in making payments, as well as risks of money laundering, terrorist financing, tax evasion, and fraud (Imf.org, 2016), were cited. Attention was also drawn to the fact that Bitcoin, which is one the most recognizable cryptocurrencies, has no standard investment value, and investments in Bitcoin are often referred to as a particular type of gambling. To clarify this issue, the Value at Risk model was used.

Facts about policy recommendations for future EU standards related to the use of cryptocurrencies were also cited (Houben, 2018). It was pointed out that regardless of the pace of changes related to cryptocurrencies and no explicit legal regulations, cryptocurrencies as a means of payment cannot remain unnoticed.

There are several definitions of e-money presented by key financial institutions, e.g., the European Central Bank (1998), the Bank for International Settlements in Basel (Bis, 2019), or bodies of the European Union (The European Parliament and The Council of the European Union, 2015). The definition presented by the European Central Bank indicates that e-money is an electronic resource of monetary value, present in a technical device that can be widely used to make payments to entities other than the issuer, without the need to engage bank accounts, functioning as prepaid bearer instrument (European Central Bank, n.d.). The European Parliament and the Council of the European Union (2000) indicate that e-money is a monetary value, which constitutes the right to claim against the issuer and which is:

- stored in an electronic device;
- issued on receipt of funds of an amount not less in value than the monetary value issued;

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- accepted as means of payment by undertakings other than the issuer.

The Directive also points out to the entities responsible for issuing and administering e-money, with particular emphasis on the issuer role, which has the ultimate financial responsibility towards the e-money holder. The definition used by the European Central Bank also implies that the device/medium on which e-money is recorded "has the features of a prepaid bearer instrument that does not necessarily use bank accounts to carry out transactions." In practice, an e-money provider can use the concept of an e-money account, treating it as a kind of virtual purse rather than a classic account.

This legal concept of electronic money implemented in the Polish legal system, together with the amendment to the Act of August 19, 2011 on Payment Services, indicates that electronic money is a monetary value stored electronically, including magnetically, issued with the obligation to redeem it, to make payment transactions, accepted by entities other than only the issuer of e-money. The Act further indicates (Sections IIIA and VIIA) that in exchange for the issue of e-money, electronic money institutions accept cash and, at the request of their holder, are required to buy e-money for cash. According to the Par. 4 of the Polish Banking Act 2019, e-money is treated as a monetary value that is the electronic equivalent of a monetary sign that meets all of the following conditions:

- is stored on electronic information carriers;
- is issued at the disposal based on a contract in exchange for cash with a nominal value not less than this value;
- is accepted as a means of payment by entrepreneurs other than those issuing it;
- is exchanged for cash by the issuer;
- is expressed in monetary units.

The complicated nature of e-money can also be demonstrated by divergent positions on the way it is classified (see Table 1).

In particular, it is about the need to use specialized software and establish online connections to enable the transfer of monetary values. The hardware-based e-money's purchasing power resides in a personal physical device equipped with a chip card, with hardware-based security features. Monetary values are transferred using device readers that do not need real-time network connectivity to a remote server. In the case of software-based e-money, specialized software must function on common personal devices to enable the transfer of monetary values. In contrast to hardware-based e-money, the personal device typically needs to establish an online connection with a remote server that controls the use of the purchasing power.

Among the opinions on understanding the e-money, some of them treat e-money as an equivalent of cash, having the same features and fulfilling the same functions, which would replace cash in cyberspace (Srokosz, 2002). Others indicate that these are a new type of non-cash money (Grodzicki, 2002, p. 11). Still, others indicate that e-money has features that make them similar to both cash and non-cash money.

The search for more stable and real-world monetary systems, particularly in the aftermath of the 2007–2010 global financial crisis, has led to a further evolution of money. This process contributed to the creation of several dichotomies, including strengthening the state monopoly in the field of money or returning to the so-called free banking and the development of private money, the creation of new joint transnational monetary units or

Table 1. Forms and types of cash, non-cash, and e-money

Source: Author.

Criteria	Cash money	Non-cash money	E-money
Form	Material form	Deposits on bank accounts	Digital information stored on electronic media
Types	Banknotes	Deposits on commercial bank accounts	Hard electronic currency does not allow reversing charges
Coins		Deposits on central bank accounts	Soft electronic currency allows payment reversals

the increase in the number and importance of local currencies. The functioning of monetary systems is subject to constant evolution, which is influenced by, among others, renaissance theories related to the so-called free banking (Timberlake & Selgin, 1991), attempts to improve the new consensus on monetary policy, dissemination of heterodox theory of monetary circulation. Globalization and internationalization of financial markets, as well as technological progress and dissemination of so-called virtual currencies with Bitcoin as one of the most recognizable, also significantly affect this process.

The complex nature of cryptocurrencies is reflected in the multitude of definitions developed by key financial market institutions, such as the European Central Bank, the International Monetary Fund, the Committee on Payments and Market Infrastructures, the European Banking Authority, the European Securities and Markets Authority, the World Bank, and, finally, the Polish National Bank. There several terms indicating that cryptocurrencies should be treated as a distributed accounting system based on cryptography that allows storing information about the account holder's possession in contractual units (Vejačka, 2014; Dourado & Brito, 2014). Others report that it is a digital or virtual currency with a limited amount in circulation, using cryptographic solutions to ensure the security of transactions, remaining outside the control of central authorities, and thus immune to government intervention or manipulation.

In the interpretation of the European Central Bank, cryptocurrencies are presented as a form of unregulated digital money, issued and controlled by its developers and accepted by the members of a specific virtual community (European Central Bank, 2012). It highlights three types of virtual currencies:

- only used in a closed virtual system (e.g., World of Warcraft Gold);
- unilaterally linked to the real economy through conversion rate – the ability to buy the virtual currency;
- bilaterally linked to the real economy through conversion rates – the ability both to purchase and sell virtual currency (European Central Bank, 2012). Bitcoin is an example of virtual currencies of the latter type (Houben, 2018, pp. 75-76).

The European Central Bank definition updated its previous definition (European Central Bank, 2015), clarifying that cryptocurrency should be understood as digital representations of value, not issued by a central bank, credit institution, or e-money institution, which in some circumstances can be used as an alternative to money. Bitcoin, however, constitutes a decentralized bi-directional virtual currency (European Central Bank, 2015). International Monetary Fund (IMF) indicates that cryptocurrencies should be understood as a subset of virtual currencies, constituting digital representations of value, issued by private developers and denominated in their own unit of account (International Monetary Fund, 2016; Natarajan, Krause, & Gradstein, 2017). IMF also indicates that virtual currencies can be broadly understood as "informal certificates of debt" by issuers, virtual currencies backed by assets such as gold, and cryptocurrencies such as Bitcoin. The World Bank, contrary to other policymakers, emphasized that cryptocurrencies should be understood as digital currencies that rely on techniques connected strictly to cryptography (Natarajan, Krause, & Gradstein, 2017). The position of the Committee on Payments and Market Infrastructures (CPMI) showed that cryptocurrencies are digital currencies or digital currency schemes with the following key features (Bank for International Settlements. Committee on Payments and Market Infrastructures, 2015):

- they are assets, the value of which is determined by supply and demand (similarly such as gold, yet with zero intrinsic value);
- they use distributed ledgers to allow remote peer-to-peer exchanges of electronic value; and
- they are not a subject of supervision to any specific institution.

Both the European Banking Authority (EBA) and European Securities and Markets Authority (ESMA) express the view that cryptocurrencies

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Table 2. Cryptocurrencies in the light of the selected central financial institutions

Source: Author.

Name of the institution	Understood as virtual currency	Understood as a digitally represented value	Understood as digital money with unregulated status	Issued and controlled by its developers without the involvement of central financial institutions (e.g., central bank)	Limited acceptance range	Conversion rate exists	Can be digitally traded
ECB	+	+	+	+	+	+	
IMF	+	+		+			
CPMI	+	+		+	+		
EBA	+	+		+			
ESMA	+	+		+			
WB	+	+		+			
FATF		+					+
NBP KNF			+	+			

should be treated as virtual currencies being digital representations of value that are neither issued by a central bank or public authority (European Banking Authority, 2014; ESMA, EBA, & EIOPA, 2018). The EBA highlighted that cryptocurrencies are not necessarily attached to a fiat currency but can be used as a means of exchange and can be transferred, stored, or traded electronically. However, ESMA also pointed out that cryptocurrencies are neither guaranteed by a central bank nor public authority and do not have the legal status of currency or money. A similar position to those discussed above was also presented by the Financial Action Task Force (FATF), also indicating that cryptocurrencies definitely do not have legal tender status (FATF, 2014). The FATF additionally divides cryptocurrencies into two basic types:

- convertible – being of a centralized or a decentralized nature and having an equivalent value in real currency;
- non-convertible – that cannot be exchanged for fiat currency and being of specific nature to a particular virtual domain or world and being under the rules governing its use.

In the Polish legal system, the status of cryptocurrency was expressed by the National Bank of Poland (NBP) and the Polish Financial Supervision Authority (KNF). In the document of July 17, 2017, it was indicated that virtual currencies (National Bank of Poland, 2017):

- are not issued or guaranteed by the central bank of the country;
- are not money, i.e., they are not legal tender or currency;
- cannot be used to pay tax liabilities;
- do not meet the criterion of universal acceptance at retail and service outlets.

It was also emphasized that virtual currencies do not have the status of e-money. The NBP and the KNF pointed out that virtual currencies were not defined in the Act of August 19, 2011 on Payment Services and in the Act of July 29, 2005 on Trading in Financial Instruments. Attention was also paid to the fact that trading the virtual currencies in Poland does not violate national or EU law. However, owning and trading them involves many types of risks (related to, e.g., the lack of state guarantee, no widespread acceptability, the possibility of fraud, high price volatility). Table 2 presents the synthetic comparison of methods of interpreting cryptocurrencies by the abovementioned central institutions.

Another complex issue regarding understanding the cryptocurrencies is to clarify whether it is possible to treat them as a medium of exchange, payment, and value measure. To provide the answer, it is necessary to refer to assumptions related to the way cryptocurrencies work. The analysis will be conducted on one of the most recogniza-

ble cryptocurrencies – Bitcoin, designed to be a "peer-to-peer version of electronic cash" allowing transactions to be made anonymously (Nakamoto, 2009, p. 1) and definition of money indicating that it is a widely accepted commodity by means of which it is possible to determine the economic value of purchased goods and services and make payments. Other definitions indicate that it is an asset that stores purchasing power (Piaszczyński, 2004). Other authors emphasize that this must be an asset with high liquidity (Duwendag, Ketterer, Kosters, Pohl, & Simmert, 1995), and predictable value (Piaszczyński, 2004). Still, other authors emphasize that it is a means of linking the present with the future (Keynes, 1956).

2. RESULTS AND DISCUSSION

From the viewpoint of economic theory, money is a rare commodity and a commodity that is traded on financial markets. It is also a legally defined payment instrument associated with a real social product that can be both material and non-material and used to express, store, and transfer values. Contemporary money can be defined, among others, through its functions and properties. The classic functions of money include: value measure (means of expressing value), unit of account (register), legal tender (means of transferring value), medium of exchange (rotational), means of storing values (means of stockv building) (Marchewka, 2001, p. 193). The literature also emphasizes that money is characterized by widespread acceptability, divisibility to smaller units, and difficulty to falsify. Against this background, Bitcoin will be analyzed to assess whether it fulfills the classic functions of money and, thus, whether it can be considered to be money.

The first of the money functions – a measure of the value of goods and services – refers to the price category, which is the value of goods expressed in cash. Money issuers perform the function of guarantors of its stability through the pursuit of monetary policy, and the amount of currency held is equivalent to the number of owned shares in all goods produced in a given economy (Michalik, 2012). Bitcoin as a cryptocurrency has no value, but it only has a rate against traditional currencies, which can be influenced by many factors, including decisions of politicians or state authorities (as was the case with MT Gox). Thus, the function of the value meter is not fully implemented by Bitcoin and is significantly different from traditional money.

One of the functionalities, which is an important value for Bitcoin users, is the possibility of making anonymous cheap online transfers, verified

Source: Blockchain.com (2020).

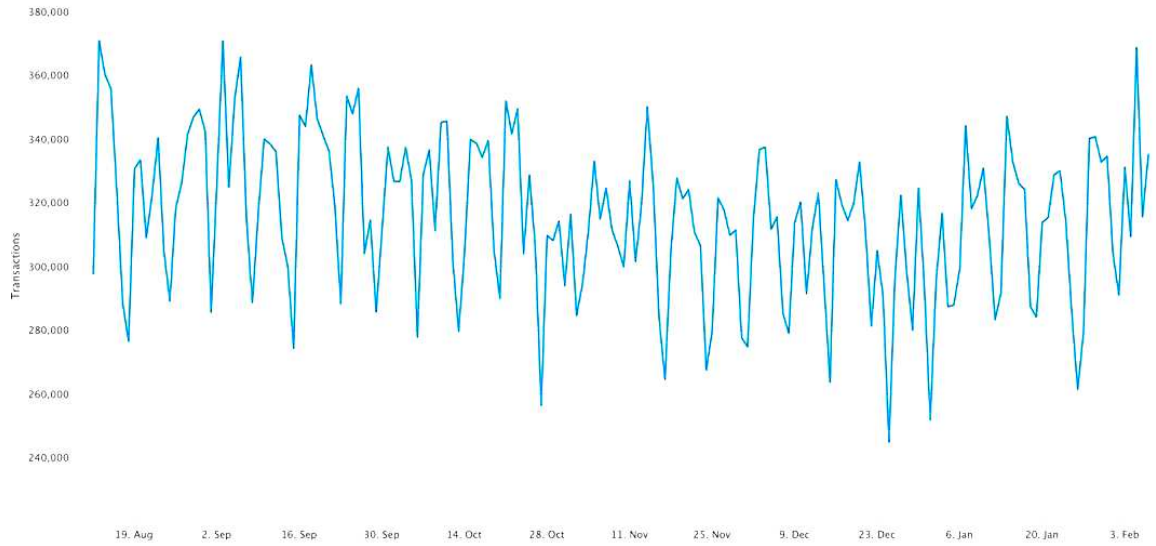

Figure 1. The number of daily confirmed Bitcoin transactions from 19th of August, 2019 to 3rd of February, 2020

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Source: Statista (2020).

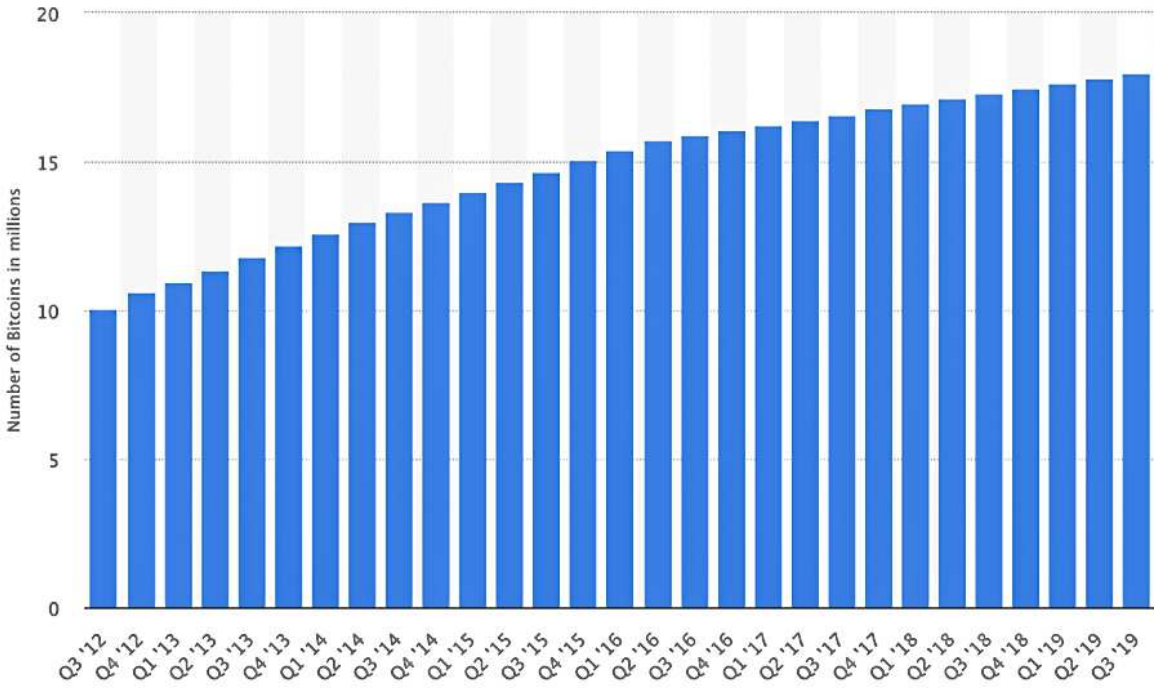

Figure 2. The number of Bitcoin in circulation worldwide from 3rd quarter 2012 to 3rd quarter 2019 (in million)

instantly, using a global network and a peer-to-peer model. However, a limited number of Bitcoin units may lead (and indeed leads) to an increase in the exchange rate and deflation of prices expressed in Bitcoin, and may also increase its susceptibility to speculative attacks and price fluctuations (Figure 1). Thus, the Bitcoin function as a means of payment seems to be highly limited.

Lack of features convergent with traditional money is also visible in the sense of treating Bitcoin as a means of storing value. For in itself, Bitcoin has no value; it only includes its speculative price. Considering the above, it can be stated that it is not possible to assign the saurization function to Bitcoin. On the other hand, Bitcoin can be assigned the function of a medium of exchange because it is acquired for the exchange for consumer goods or production of goods. It also can be said that Bitcoin is a rare good, which results from the algorithmically limited number of units in circulation (up to the volume of 21 million items) (see Figure 2).

The easy transfer feature can be easily assigned to Bitcoin thanks to the extensive Blockchain network and ATM devices (bitomats that enable Bitcoin cryptocurrency to be purchased), as well as divisibility into smaller units through which transactions in the network are carried out (Hassani, Huang, & Silva, 2019). It seems controversial, however, to attribute it to the universality of acceptance due to a relatively small number of system users (see Figure 3).

The quantities presenting the number of Bitcoin daily transactions in the 1Q of 2020 was only 334,938 (Statista, 2020; Blockchain.com, 2020), as well as the number of ATM supported cryptocurrencies (worldwide), seem to be relatively small (see Figure 4).

The Bitcoin treatment seems to be also doubtful as a standard investment value. In case of acquisition of standard investment securities, the investor maintains certain guarantees in the event of a decrease in their price (e.g., the possibility to wait for the maturity of the debt in case of bonds). Investments in Bitcoin seems to be a certain type of gambling, similar to investing in futures without a lower price limit.

Based on the above, it can be argued that Bitcoin does not fulfill all the functions of traditional

Source: Quandl (2020).

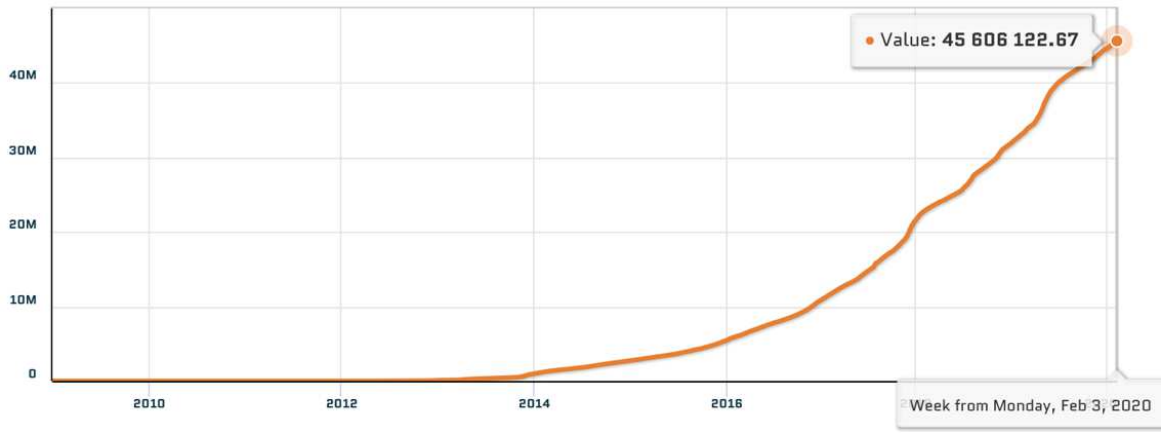

Figure 3. The number of Bitcoin wallet holders as of February 5, 2020

money. Bitcoin should also not be considered as e-money, despite showing considerable similarities to this means of payment. The justification for the above thesis is, among others, provisions of Art. 2 point 2 of the Directive 2009/110/EC. The document indicates that electronic money means monetary value stored electronically, including magnetically, constituting the right to a claim against the issuer, which is issued in exchange for cash in order to perform payment transactions specified in Art. 4 point 5 of Directive 2007/64/EC and accepted by natural or legal persons other than the issuer of electronic money. The Directive indicates a closed catalog of entities entitled to issue electronic money: credit institutions (Article 4 point 1 of Directive 2006/48/EC), electronic money institutions, postal giro institutions (if they are entitled to issue electronic money under the domestic law), national central banks and the European Central Bank if their role does not constitute them as monetary authorities or other public bodies, member states or their bodies, if they do not act as public bodies.

Bitcoin, in opposition to e-money and traditional money, has no single issuer. It remains outside the direct control of central financial institutions and without adequate economic support. Units of

Source: Coin ATM radar (2020).

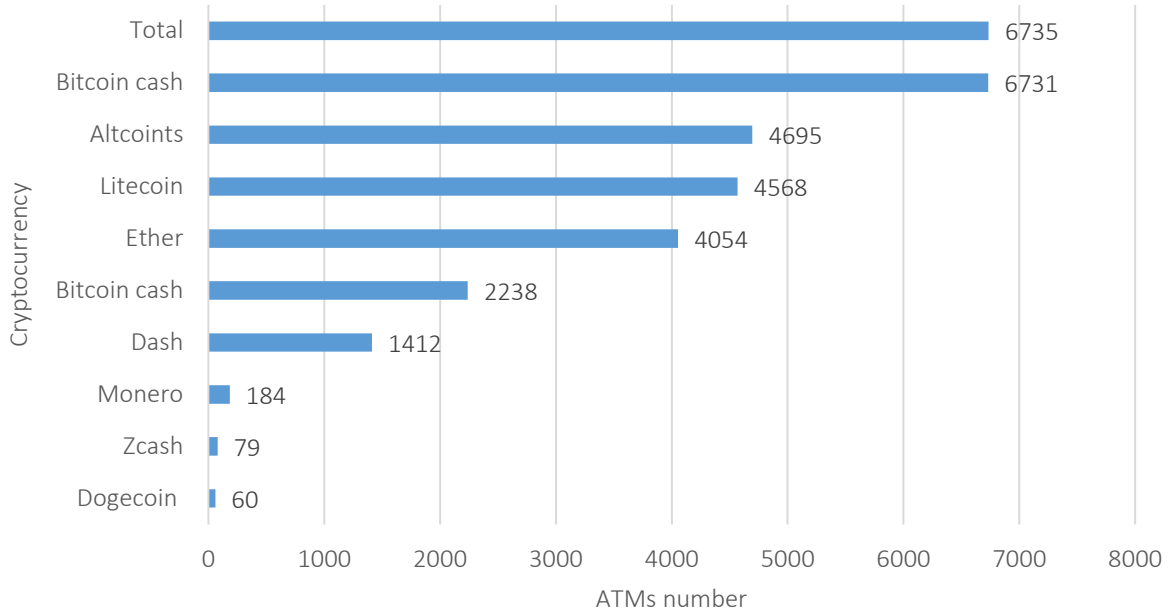

Figure 4. Crypto ATM supported cryptocurrencies (worldwide)

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this cryptocurrency are created by the system automatically, in a manner planned in advance by the system's creators, based on emission assumptions inscribed in the source code of cryptocurrencies. As a result of these activities, the number of Bitcoins in circulation is a function of the nominal value of transactions performed and the said rigid limitation of the number of units in circulation. It should be noted that standard currencies are manually controlled, allowing them to maintain their relative stability in the face of the changing market situation. Bitcoin, on the other hand, being automatically controlled, seems to be less resistant to market shocks. The above allows stating that the Bitcoin cryptocurrency does not meet provisions of Directive 2009/110/EC, defining e-money.

As indicated earlier, it seems that Bitcoin has no standard investment value. Investments in Bitcoin are often referred to as a particular type of gambling and resemble investments in futures without a lower price limit. To assess the risk of investing in Bitcoin, it is necessary to use the risk measure. The problem of measurement and monitoring of investment risk (including financial investments) is one of the greatest challenges of modern economics. The literature on the subject refers to the above issues through volatility measures (variance of rate of return, standard deviation of the rate of return, coefficient of variation of the rate of return), measures of sensitivity (beta coefficient, duration of investment) or measures of risk (semi-refund of rate of return, standard semi-error rate of return, Value at Risk).

According to Markowitz (2000), the risk measure of the investment portfolio is the variance of the return on the investment portfolio. The imperfection of the method (as the variance of the rate of return included both surpluses over the expected value and decreases below the expected value measured in squares) was adjusted by the so-called semivariance. However, this correction led to the loss of the analytical form of the solution proposed by Markowitz (2000). In 2006, the Basel Committee on Banking Supervision recommended the use of the so-called Value at Risk (VaR) measure. Originally, VaR was only used as an internal measure used to estimate risk in banks (as a method of assessing market risk, it was introduced through an amendment to the Basel II contract).

Here, however, arises the problem of possibility to increase the degree of risk exposure (VaR may increase) generated by the portfolio of assets, with its diversification. The VaR measure is the amount an investor may lose (value of losses) as a result of investing in the portfolio with the assumed time horizon and confidence level. It is also admissible that this is the value of losses that may be exceeded with probability α or a loss value, which with probability equal to $(1-\alpha)$ may not be exceeded on the following day. Summing up, the VaR method allows obtaining information on the general risk level regardless of the type of assets analyzed. The following conclusions emerge from the VaR method:

- when a given asset brings higher profits, with a lower level of VaR risk, it should have been increased;
- when a given asset brings higher profits, with the same level of VaR risk, the involvement in this asset should have been increased.

Value at Risk (VaR) can be considered in absolute terms (through the current value of capital employed in the investment) as well as in relative terms (through the expected value of capital employed in the investment). Probability allows us to predict, estimate unknown results based on known parameters, while the credibility allows us to estimate the unknown parameters based on known results.

For the needs of the present paper, the risk of investing in Bitcoin was compared on the selected world exchanges (Bitfinex, GDAX, Bitstamp, BTCC, Gemini) and the risk of investing in selected traditional currencies – USD, AUD, CAD, EUR, HUF, CHF, GBP (exchange rate in relation to PLN from January 1, 2009 until December 10, 2017). The choice resulted from the 24 Hour Volume Rankings – Currency. The VaR measure was adopted in relative terms, understood as the maximum value that an investor would like to lose as a result of an investment, for a given period of time, with the assumed tolerance level (see equation (1)):

Source: CoinMarketCap (2017).

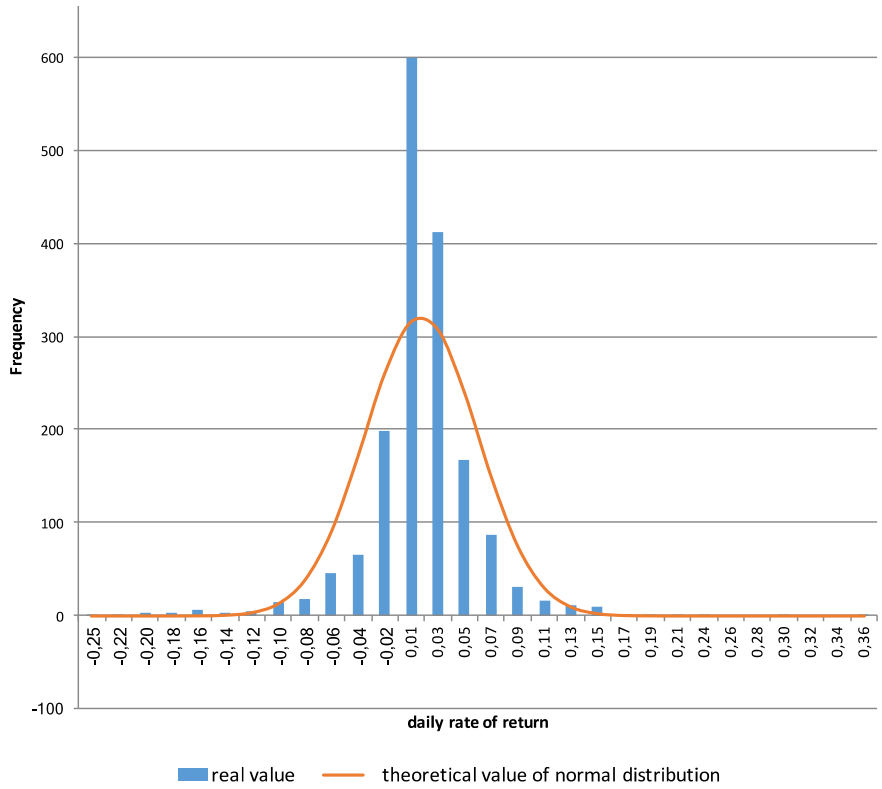

Figure 5. Histogram of daily returns on the BitFinex stock market – selection based on the capitalization value as of December 15, 2017 (1,706 quotations in the period 2013–2017)

$$
\begin{aligned}
&P\left(W \le \left(E\left(W\right) - VaR_R\right)\right) = \alpha,\\
&P\left(W > \left(E\left(W\right) - VaR_R\right)\right) = 1-\alpha,\\
&VaR_R = E\left(W\right) - W_\alpha,\\
&VaR_R = W_0\left(1 + \left(E\left(r\right)\right) - W_0\left(1 + r_\alpha\right)\right),\\
&VaR_R = W_0 E\left(r\right) - W_0 r_\alpha =\\
&= W_0\left(E\left(r\right) - r_\alpha\right) = -W_0\left(r_\alpha - E\left(r\right)\right),
\end{aligned}
\tag{1}
$$

where α is accepted tolerance (0.05 or 0.01).

In the calculation of Value at Risk, the method of the historical simulation was used, which focuses on the statistical analysis of the empirical distribution of return rates. Besides, this method allows for better mapping of market behavior. It should be noted that the distribution of returns on the analyzed exchanges did not have the characteristics of normal distributions.

An assumption regarding the normality of the distribution of rates of return was also adopted. This assumption may be encountered in many areas of finance and valuation models (e.g., the Black-Scholes option valuation model), forecasts (e.g., using the National Science Committee), risk assessment or verification of economic theories. It allows calculating the probability of gain or loss from a given investment or value at risk (VaR). The adoption of the above assumption results directly from the central limit theorem, indicating that the use of a normal distribution is permissible for each continuous random variable, subject to the independence of individual variable values, the origin of observations from the same distribution and their sufficiently large number – min. 30 (the assumption was fulfilled in the conducted study).

The time series of Bitcoin returns on selected exchanges were analyzed. As expected, the results obtained confirmed that time series are burdened with high kurtosis (leptokurtic distribution) and skewness. The results of Chi-square tests also confirmed the need to reject the null hypothesis about the normality of rates of return for 0.05 and 0.01 confidence levels. Thus, it was confirmed that the

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Table 3. Investment risk for selected exchanges and confidence levels with a period of 10 days

Source: Author.

Trade	Volume	VaR(0.05)	Change (%)	VaR(0.01)	Change (%)
Bitfinex	$479028000,00	–$109332053,49	–22.82%	–$154593529,73	–32.27%
Gemini	$96122500,00	–$22003814,72	–22.89%	–$31112992,73	–32.37%
BTCC	$294397000,00	–$67391682,93	–22.89%	–$95290610,63	–32.37%
Bitstamp	$117389000,00	–$26872020,66	–22.89%	–$37996547,15	–32.37%
GDAX	$209344000,00	–$47921835,04	–22.89%	–$67760600,80	–32.37%

rates of return from Bitcoin do not have a normal distribution. Histogram of daily Bitcoin returns on the Bitfinex stock market is shown in Figure 5.

The results of the Value at Risk (VaR) calculations, together with their percentage change for 0.05 and 0.01 confidence levels, are presented in Table 3.

The analysis of tabular data indicates that investments in Bitcoin are subject to high risk, which may lead to a reduction of the initial capital value by about 21% for the 0.05 confidence level and about 32% for the 0.01 confidence level (in the 10th day). Besides, there was a negligible correlation of the Bitcoin return rate in relation to the number of Bitcoins remaining in circulation, quarterly (for Bitfinex, it is 0.277771642) (Figure 6).

Similar analyses were performed for selected currency pairs, performing an average of 250 observations/year, which resulted in a total of 2,275 observations for each currency during the study period. It was also assumed that the average change for one day is zero, which for a portfolio of one asset may be expressed as follows:

$$Var = W \cdot \sigma \cdot k, \tag{2}$$

where W – value of the portfolio on the previous day (in the previous period), σ – standard deviation of t.he price of the asset, k – number of standard deviations below average (the following values were assumed – for the confidence level $c = 0.95$, the $k = -1.645$ and for the confidence level $c = 0.01$, the $k = -2.326$).

Source: Author.

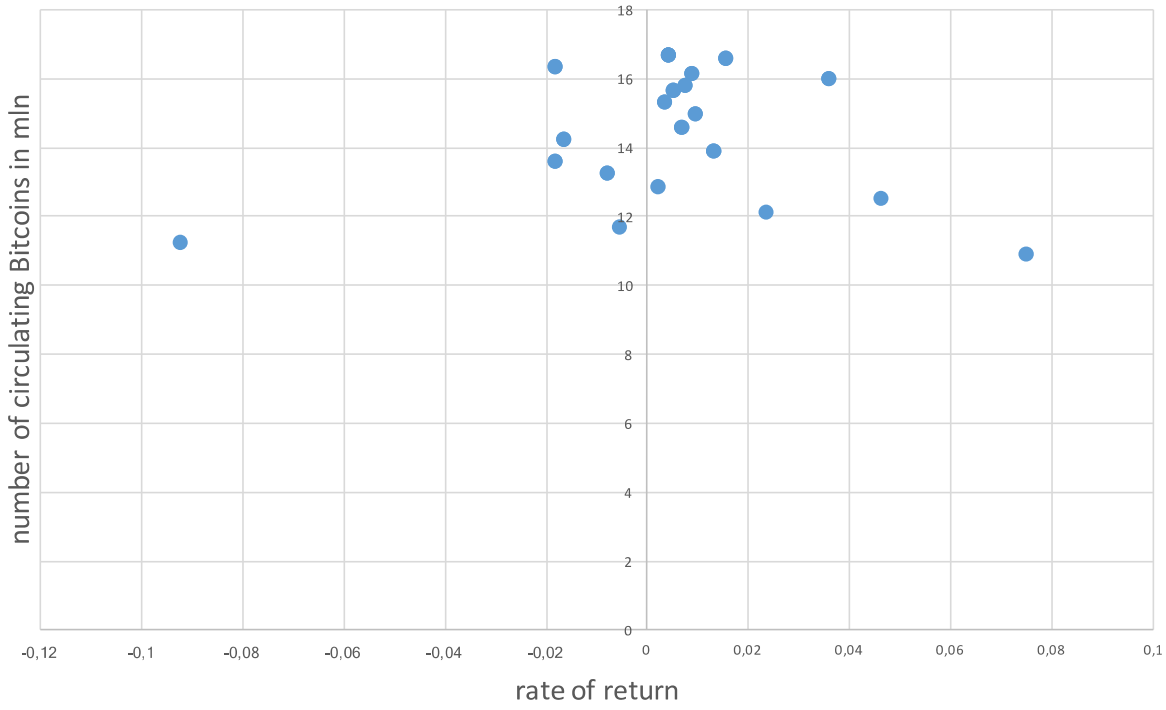

Figure 6. Correlation of the rate of return from Bitcoin in relation to the number of Bitcoins in circulation for the Bitfinex Stock Exchange (million, 2018)

Source: Author's study based on CoinMarketCap (2017a).

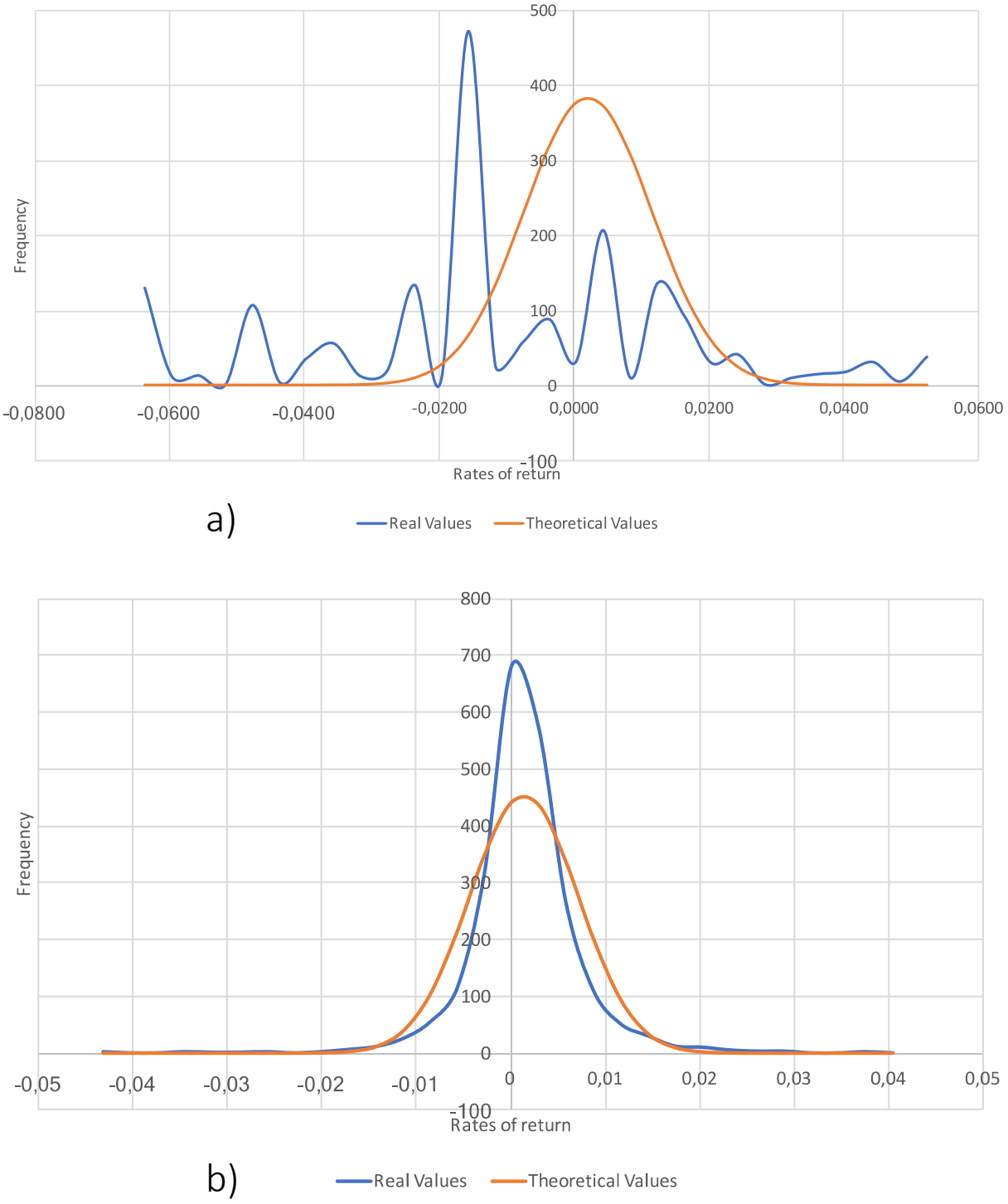

Figure 7. Histogram of daily rates of return for USD (a) and EUR (b), respectively (2,275 observations in the period 2013–2017)

It should be highlighted that VaR value of the portfolio consisting of a single asset (such a simplifying assumption was assumed) is a function of the portfolio value, asset price volatility, tolerance level, and time horizon.

As in the case of exchanges, the analysis of the time series of the return rates of the currencies examined showed that the time series significantly differ from the normal distribution – they are burdened with high kurtosis (4.303 for USD – lep-

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tokurtic distribution) and skewness (0.1333 for USD). The results of Chi-square tests also pointed to the necessity of rejecting the null hypothesis on the normality of rates of return for 0.05 and 0.01 confidence levels. Thus, the time series of the rates of return for the examined currencies do not have a normal distribution (see Figure 7).

Table 4 presents the results of the Value at Risk calculations – VaR for the amount of 100 million units, together with the percentage change in its value for 0.05 and 0.01 confidence levels.

Table 4. Investment risk in traditional currencies expressed in terms of value at risk in relative terms over 10 days

Source: Author's study based on CoinMarketCap (2017a).

Trade	Change (%) for VaR (0.05)	Change (%) for VaR (0.01)
USD/PLN	–4.88%	–6.90%
AUD/PLN	–3.82%	–5.40%
CAD/PLN	–4.06%	–5.74%
EUR/PLN	–2.97%	–4.20%
100 HUF/PLN	–2.54%	–3.59%
CHF/PLN	–4.46%	–6.31%
GBP/PLN	–4.09%	–5.78%

The results of VaR analysis for the selected currency pairs unambiguously indicate that investments in Bitcoin are burdened with much higher risk (about 5 times higher for 0.05 confidence level and 6 times higher for 0.01 confidence level).

The paper clearly indicates the complex nature of cryptocurrencies. This complexity concerns both definition and legislative issues, as well as issues related to trading aspects, including risks. Despite the growing popularity of cryptocurrencies, many countries do not sanction this means of payment, paying attention to its speculative nature.

However, it is difficult to state that cryptocurrencies will cease to be an element of the modern economy. Similar doubts existed with respect to e-money, which now for good fits into the financial instruments of the e-economy. The considerations presented by the author seem to confirm the thesis of the speculative nature of cryptocurrencies. The high volatility of the cryptocurrencies values, its sensitivity to political decisions, the lack of centralized supervision, no or very limited legal regulations regarding this instrument makes this instrument high-risk.

Nevertheless, the future of cryptocurrencies will be verified by the market, by the users of this form of the payment, and by the investors who will or will not decide to put their money in it.

CONCLUSION

The dynamically growing interest in cryptocurrencies is due to many reasons, including transaction anonymity, speed of transaction execution, lack of or small commissions on executed transactions, independence from governments and banking systems. The main conclusion that can be drawn is that there is no generally accepted definition available in the regulatory space. Moreover, most policymakers have refrained from defining the term altogether, while some have limited only to name them as a subset of virtual or digital currencies (the World Bank and the FATF), different from e-money. The analyses made in the paper indicate that despite the growing popularity of cryptocurrencies and often equating them to money, they do not meet the definition of both e-money and money in general. It is not excluded, however, that Bitcoin (like other cryptocurrencies) may in the future become money functioning in modern economies, but due to the lack of its value in use (it is empty money) or dependence on complementary capital goods, obtaining it as money is relatively unlikely.

The changes in the legislative system referring to the cryptocurrencies (e.g., banking law or tax law) are underway. However, it should be emphasized that the results presented in the paper seem to confirm the thesis of the speculative nature of cryptocurrencies. The high volatility of the cryptocurrencies values, their sensitivity to political decisions, the lack of centralized supervision, no or limited legal regulations make them high-risk instruments.

Regardless of the pace of changes related to cryptocurrencies, it should be stated that non-cash payment instruments are of significant importance for reducing the costs of cash transactions and further development of e-business. The dynamic development of cryptocurrencies and their increasing popularity as a means of payment cannot remain unnoticed.

AUTHOR CONTRIBUTIONS

Conceptualization: Jacek Binda.
Data curation: Jacek Binda.
Formal analysis: Jacek Binda.
Investigation: Jacek Binda.
Methodology: Jacek Binda.
Project administration: Jacek Binda.
Resources: Jacek Binda.
Validation: Jacek Binda.
Visualization: Jacek Binda.
Writing – original draft: Jacek Binda.
Writing – review & editing: Jacek Binda.

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