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Cryptocurrency: Value Formation Factors and Investment Risks

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Abstract

Scientific sources demonstrate different attitudes of researchers to cryptocurrencies because they treat them as a category of currency, virtual money, commodity, etc. Accordingly, the relation to the valuation and risk of cryptocurrency as an investment object is different. The purpose of the article is to identify cryptocurrency value formation factors and determine the risks of investing in cryptocurrency. Cryptocurrency is simultaneously considered a currency, an asset with uncertain income, and a specific product, the price of which is determined by the energy costs for mining new cryptocurrency blocks. Thus, the paper examines the risks of investing in cryptocurrency from several positions. First, the study identifies the factors of formation of the value and risk of cryptocurrency as ordinary money based on comparing cryptocurrency with traditional money. Unlike traditional money, cryptocurrency is not tied to the economic performance of a particular country; also, central banks do not control or

regulate their mining. Instead, the cryptocurrency emissions depend on the computational capacity of the equipment used for their mining. As a financial asset, cryptocurrency can be a "financial bubble" because their value increasing often exceeds the cost of mining. On the other hand, given the emergence of cryptocurrency as a phenomenon of the information economy, the paper analyses the impact of specific technical features (cryptographic hashing algorithm, the complexity of creating new blocks, the technology of verification of mining operations, etc.) on the risk of investing in cryptocurrency assets.

Keywords: Cryptocurrency; Digital currency; Bitcoin; Blockchain; Risk; Financial services; Financial asset; Investment.

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Introduction

Modern scientific studies show increasing attention to technological aspects of economic development. At present, not only economic but also social, political, demographic, and cultural processes are heavily influenced by digitalization. These processes allowed us to speak about the transition to the fourth industrial revolution in the economic environment. Fast technological advances in digitization supercharge performance and enable new business innovations and new forms of competition (Bilan et al., 2020a, Boyarko and Samusevych, 2011; Chigrin and Pimonenko, 2014; Stukalo et al., 2020). Virtualization and decentralization spread not only to the sphere of production but also to the processes of product promotion, service provision, and information exchange.

In the financial environment, digitalization has led to significant changes in the types of financial services (Druhov et al., 2019; Pakhnenko et al., 2021; Gontareva et al., 2020; Guryanova et al., 2020), the ways they are provided, the nature of financial intermediation (Kozmenko and Kuzmenko, 2011; Kuzmenko and Bozhenko, 2014; Leonov et al., 2019; Leonov et al., 2020), and updating related cybersecurity and financial security issues (Bilan et al., 2020b; Boyko and Roienko, 2014; Brychko et al., 2021b; Lyulyov et al., 2021; Kuzmenko et al., 2020; Petroye et al., 2020; Syniavska et al., 2019; Yarovenko, 2020; Yarovenko et al., 2021; Babenko et al., 2020).

One of the areas of technological development, which is reflected in the functioning of the money market, was the spread of blockchain technology and its use as the basis of cryptocurrencies (Lopez et al., 2019). Cryptocurrency is a phenomenon of the modern world, an example of the development of information technologies, virtualization, and decentralization in the field of monetary and financial relations. The attitude to

cryptocurrency in the world is ambiguous. Differences concerning the interpretation of cryptocurrencies and their assignment to a particular category exist in the scientific sources and the attitude of governments and regulatory bodies of various countries and interstate structures (FATF, 2014; Stukalo et al., 2021; Vasylieva et al., 2020; Babenko, 2019; Bondarenko et al., 2019; Kuznetsov et al., 2020). To some extent, this can be explained by the relative novelty of cryptocurrencies as an economic phenomenon.

Many of the features and performed functions characterize cryptocurrencies as a "currency" category. In particular, cryptocurrencies allow using them in payments as a measure of the value of goods and services. At the same time, the possibility of using cryptocurrencies to conduct payments depends not on the nature of goods or services to be paid but on the consent to accept cryptocurrencies by the seller of the products as a means of monetary circulation and payment. The pegging such a cryptocurrency to one of the existing traditional currencies (most often to the US dollar) determines the value of the product expressed in the cryptocurrency. Today, many business entities involved mainly in e-commerce (Amazon, Subway, Tesla, and Reddit) accept cryptocurrencies, mainly Bitcoins, for payment.

One can agree that the essence and functions of traditional money are changing under the influence of virtualization and global financial integration. The credit nature of money (debt) changes to a digital-credit character. The transitivity of money, which ensures the circulation of the monetary system in cyberspace and the movement of goods and service values within the framework of the global economy between its participants, becomes of paramount importance.

The rapid spread of virtual currencies, if they are generally recognized as a means of payment and an exchange medium, can significantly change the structure and volume of consumption, affect the level of savings and investment activity (Choudhary and Dhillon, 2018; Kobushko et al., 2021; Kolosok et al., 2018; Kozmenko S. & Korneyev, 2017). On the other hand, many barriers do not allow virtual currencies to become dominant in money circulation. Several cryptocurrencies' characteristics distinguish them from traditional currencies and electronic money. Such main features are their irregularity and their decentralized nature. In most countries, the state tightly controls the issuing of electronic money by defining the entities entitled to issue e-money and the conditions for their issuance. The emission of traditional money is the state's exclusive right (Vasilyeva et al., 2016; Gutorova et al., 2019; Danylyshyn et al., 2019; Zavhorodnii et al., 2021).

In contrast, the cryptocurrency issuance and circulation mechanism provide for the absence of intermediaries such as a central bank, traditional financial and credit institutions. Moreover, the issuance of cryptocurrencies does not imply a restriction on the existence of a single issuer. Any system user, which can provide the power of their computer for complex calculations, may issue (carry out "mining") cryptocurrencies.

Unlike electronic money, cryptocurrencies are not backed by traditional cash, non-cash money, or other highly liquid assets. Also, the issuer of a cryptocurrency is not liable for its repayment or converting the value into traditional means of payment. Considering this, the standard monetary regulation for traditional payment means based on state and international regulatory documents cannot be extended to the circulation of cryptocurrencies (Petrushenko et al., 2018).

Since cryptocurrencies do not have the status of a legal payment instrument, the quality of realization by them of such functions of money as a means of circulation and payment may be unsatisfactory. The liquidity of some cryptocurrencies is so low that the use of the term "currency" or "money" regarding them is inappropriate (FATF, 2014). Simultaneously, the most popular cryptocurrencies, such as Bitcoin, Ethereum, XRP, Litecoin, Tether, and others, have a sufficiently high level of liquidity due to a large number of digital currency exchanges, which provide for exchanges of cryptocurrencies for traditional currencies and among themselves. The ability to convert cryptocurrencies into fiat (traditional) money is an incentive for many users to maximize the amount of virtual currency created solely to exchange it for real money.

The modern exchange and capital market are characterized by introducing many innovative financial instruments used for either hedging currency risks, speculative operations, or portfolio investments. Recent research defines the dependence of the dynamics in capital market capitalization upon developing innovations in financial technologies (Paskevicius and Keliuotyte-Staniuleniene, 2018). From this point of view, cryptocurrency is also a financial innovation and an alternative investment asset with high profitability. In the long run, mining cryptocurrencies may be considered a source of profit for investment funds, banks, and other institutional investors (Kozmenko & Roienko, 2013; Shkolnyk et al., 2017; Kaganovska et al., 2018).

However, investing in cryptocurrencies is not risk-free. But the impossibility of unambiguously assigning cryptocurrencies to one of the existing categories of investment assets makes it difficult to apply the traditional methods of investment risk assessment. From the investment point of view, it is possible to consider cryptocurrency as a currency, a financial asset with non-fixed income, and a specific commodity with a prime cost determined by the energy consumption for mining new cryptocurrency blocks.

Thus, the risk assessment of investing in cryptocurrencies cannot be limited only by analyzing speculative operations of their buying and selling on cryptocurrency exchanges. It is also necessary to comprehensively cover the financial and technical risk factors of cryptocurrencies. Assessing the financial risks of investing in cryptocurrencies requires a two-way assessment. On the one hand, the risk analysis of cryptocurrencies can be carried out using the methodology for evaluating traditional currencies. On the other hand, the price fluctuations existing in the cryptocurrencies market make it possible to compare them with

the dynamics of the so-called "financial bubbles" markets. The danger of speculations in the financial market and such "financial bubbles" for the world economy has shown its devastating effect during the financial crisis of 2008-2009 (Bondarenko et al., 2020; Buriak et al., 2015; Djalilov et al., 2015; Kozmenko and Kuzmenko, 2013; Kozmenko and Vasyl'yeva, 2008; Kuzmenko, 2014). Thus, this requires an independent assessment of the speculative component in the formation of the value of the cryptocurrency and its impact on investment risk. In addition to the financial risks of investing in cryptocurrencies, it is also necessary to pay attention to the technical risks associated with the features of the algorithms used, types of hashing, and other characteristics that determine the specificity of cryptocurrencies' mining and circulation.

Thus, the article's purpose is to identify and analyze cryptocurrency cost formation factors as an investment asset, as well as to study the risks of investing in cryptocurrency through simultaneous consideration of its signs of currency, an asset with non-fixed income and a specific commodity, the prime cost of which is determined by the energy consumption for mining new blocks of cryptocurrency.

Given the comparative novelty of the cryptocurrency phenomenon and its popularity as an investment asset, the number of scientific papers on this subject is not very large today. In a number of works, the subject of research is broader and covers the issues of the circulation of electronic and virtual money in general. The works of Brezo and Bringas (2012); Eyal and Sirer (2013); Hanley (2013), and others carry out an analysis of the risks, threats, and problems associated with the circulation of electronic money, cryptocurrency, and in particular, Bitcoins. For example, the work of Moore (2013) focuses on the potential risks that can be caused by the widespread use of decentralized electronic currencies that are beyond the control of regulators, namely their use in shadow and illegal transactions.

Another area of research is the analysis of cryptocurrencies' pricing and risk accounting in the formation of their market value, as well as modeling the functioning of the cryptocurrency market and analyzing its volatility. In particular, Cocco and Marchesi (2016) use the agent-based model to study the cryptocurrency mining economy and the functioning of this market as a whole. Researchers Bornholdt and Steppen (2014) created a model based on the Moran process to predict the possibilities of the emergence of new cryptocurrencies. The work of Luther (2013) is also worth mentioning among the studies devoted to cryptocurrencies; it explores the reasons for the non-recognition and failure of some cryptocurrencies on the market using a simple agent model.

The other group of works represents a narrower range of studies, focusing on analyzing Bitcoin as the most popular cryptocurrency, the factors shaping its price, and the functioning of the Bitcoin market. In particular, Donier and Bouchaud (2015) explore the relationship between price drops in the Bitcoin market and the level of liquidity in such a market. Another

work (Kristoufek, 2015) presents a thorough analysis of the factors that influence the formation of the price of Bitcoins. The author applies continuous wavelet analysis, particularly wavelet coherence, to study the price fluctuations over time and for different scales (frequencies). This study focuses on various factors in the formation of cryptocurrencies prices, including the speculative and technical components, and on changing the determining factors that impact the price formation of Bitcoin due to its rapid development in recent years.

A group of scientists (Garcia et al., 2014) pays attention to the speculative component in the circulation of cryptocurrencies. They associate sharp changes in the exchange prices of Bitcoin and the formation of price bubbles with the influence of social interaction between market participants and other social phenomena. Similar conclusions are in the work of Kaminsky and Gloor (2014). They relate the dynamics of Bitcoin exchange prices with the influence of users' sentiment on this cryptocurrency on social networks. Kirichenko et al. (2017) emphasize that social networks are used in the interests of information influence: "they provide opportunities in terms of influence on the formation of public opinion, the adoption of political, economic and military decisions." In general, the development of the social sector correlates with economic and ecological indicators and has a complex structure. Moreover, according to the behavioral finance theory, behavior is a leading indicator of risk, and human's behavior is primarily irrational and, therefore, unpredictable (Brychko, 2013; Brychko et al., 2021a; Didenko et al., 2020; Lyeonov and Liuta, 2016; Njegovanović, 2018; Prince, 2018).

To sum up, complexity, irrational behavior, the influence of social networks, economic, social, and environmental sentiment form a high level of uncertainty regarding the pricing of cryptocurrencies and require a detailed study of each component.

Results and Discussion

Cryptocurrencies are the most advanced form of virtual money. Their circulation is based on blockchain technology, that is, on the chains of transaction data blocks stored on all computers in the system and connected so that each subsequent block contains references to the previous one. Despite the debatability and ambiguity of Bitcoin (the first cryptocurrency launched in 2009), in 2011, new cryptocurrencies began to emerge based on principles similar to Bitcoin. However, they had some differences from it and attempted to improve the first cryptocurrency. Currently, about 9 thousand varieties of cryptocurrencies have been created. The market's capitalization level ($1.3 trillion in Q2, 2021) indicates a sustained interest in cryptocurrencies. Table 1 presents data on the market capitalization of the dominant cryptocurrencies in the second quarter of 2021.

Table 1. Market capitalization of the TOP10 cryptocurrencies as of June 30, 2021

The name of the cryptocurrency	**Market capitalization**			**Market dominance, %**
	millions of USD	**millions of USD**	**thousands of BTC**	
Bitcoin (BTC)	654061.7	551479.4	18745.2	49.7
Ethereum (ETH)	255829.3	215953.5	7332.0	20.0
Tether (USDT)	62883.0	52815.6	1829.1	4.7
Binance Coin (BNB)	44076.9	37197.7	1284.5	3.5
Cardano (ADA)	41974.6	34964.3	1268.0	3.3
Dogecoin (DOGE)	31860.3	26885.2	928.6	2.5
XRP (XRP)	30573.8	25799.6	891.1	2.4
USD Coin (USDC)	25146.7	21222.0	732.8	1.9
Polkadot (DOT)	15435.6	13026.5	450.0	1.2
Binance USD (BUSD)	10097.5	8521.5	294.3	0.8

Source: CoinGecko

Despite the emergence of many new cryptocurrencies, Bitcoin remains the most popular, most expensive, and capitalized cryptocurrency. The share of Bitcoin by capitalization volume covers almost half of the cryptocurrency market – 49.7%. A significant percentage of the crypto market is occupied by Ethereum – 20.0%. The remaining cryptocurrencies occupy no more than 5% of the market each and constantly change their positions in the top cryptocurrencies. In the second quarter of 2021, the top 10 most capitalized cryptocurrencies included Tether, Binance Coin, Cardano, Dogecoin, XRP, USD Coin, Polkadot, and Binance USD.

1.1. Factors of cryptocurrency value formation

The use of cryptocurrency, as a rule, includes two directions: payment using cryptocurrency for certain goods and services and speculative operations with cryptocurrency (Kristoufek, 2015). As for the first direction, it should be noted that the use of cryptocurrencies in payment transactions is limited: firstly, not all cryptocurrencies can be an exchange medium due to their unpopularity and low liquidity; and secondly, only a few business entities, mainly in e-commerce, accept cryptocurrencies as an exchange medium. Therefore, market participants most often consider Bitcoins and other cryptocurrencies as speculative assets that generate income due to the difference in sale and purchase price on cryptocurrency exchanges and over-the-counter trading platforms.

Summarizing the features of the essence and practical use of cryptocurrencies, the factors that form their value include the following:

– the volume of emission and the use of cryptocurrency as a means of payment;
– cost of cryptocurrency mining;
– speculative factor.

The influence of each of these factors on the value and investment risks of cryptocurrencies will be characterized by the example of Bitcoin as the first and most popular cryptocurrency.

Although Bitcoin most often acts as a speculative asset, one cannot deny its role in servicing transactions to purchase and sell ordinary goods and services. When Bitcoin performs as an exchange medium and a transfer of value, it manifests itself as a universal measure of value. In other words, it has signs of the regular currency, to which known economic and monetary laws can be applied. One of such basic economic patterns is the relationship between the value of money (the exchange rate of cryptocurrency) and their purchasing power (Dave, 2017).

At the same time, Bitcoin does not belong to the legal tender of any country; therefore, its use for payment of goods and services requires the establishment of an exchange rate with the traditional currency.

The principal currency through which Bitcoin expresses its value is most often the US dollar. Still, it is not the only traditional exchange currency common to use for exchange transactions with Bitcoin. According to Bitcoincharts, 32% of trading volumes of Bitcoin is in Euro, 6% is in Polish zloty. It is also traded in Japanese yen, Canadian dollar, Australian dollar, British pound, Brasileira real, etc.

Such trading platforms and cryptocurrency exchanges as Kraken, Bitstamp, Bitbay, BTCmarkets, Coinsbitio, and others have the most significant trading volumes of cryptocurrencies, particularly Bitcoins (Figure 1).

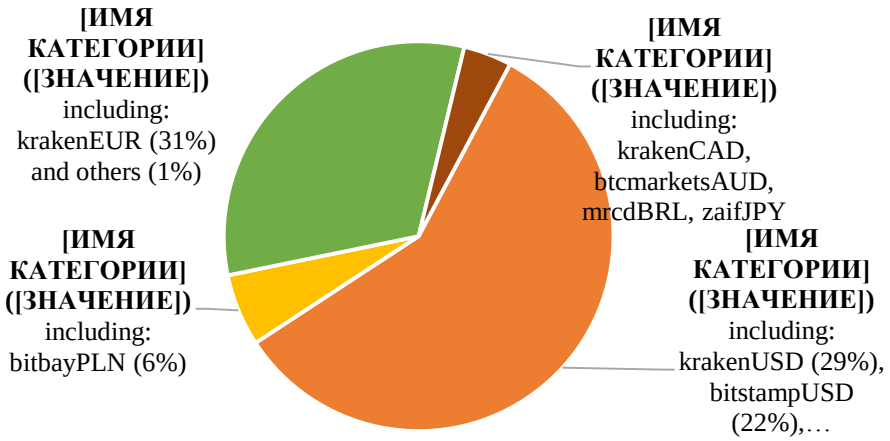

Figure 1. The structure of Bitcoin trading volumes by currencies and cryptocurrency exchanges in June 2021

Source: formed by the authors based on data of Bitcoincharts

It should be noted that Bitcoin quotations on various exchanges and in different currencies are somewhat different. Thus, it is not entirely correct to associate the market value

of Bitcoin or other cryptocurrencies exclusively to the US dollar. In our opinion, when considering Bitcoin as a kind of currency, it is necessary to bind its market value to a basket of the major currencies (for now, they are US dollar, Euro, and Polish zloty), which provide about 96% of the volume of Bitcoin exchange trading. There are several approaches to calculating the exchange rate index of a particular currency pegged to a basket of currencies. In the practice of many central banks and international organizations, the approach to calculating the exchange rate index as a geometrically weighted average of bilateral exchange rates is widespread (Loretan et al., 2005):

$$I_t = I_{t-1} \times \prod_{j=1}^{N(t)} (e_{j,t}/e_{j,t-1})^{w_{j,t}} \quad (1)$$

where I_{t-1} is the value of the index at time $t-1$; $e_{j,t}$ and $e_{j,t-1}$ are the prices of Bitcoin (or another cryptocurrency) in terms of foreign currency j at times t and $t-1$; $w_{j,t}$ is the weight of currency j in the index at time t; $N(t)$ is the number of foreign currencies in the index at time t; and $\sum_j w_{j,t} = 1$.

The advantage of this formula is the ability to change the number of currencies included in the basket and their weights over time. The procedure allows taking into account the most significant quotations of each cryptocurrency to the traditional currencies and introducing corrections to the index calculation when the currency structure of cryptocurrency trading volumes changes. We propose to determine the weights of the currencies included in the currency basket proportionally to the volume of exchange contracts concluded in such a currency to Bitcoin or another cryptocurrency for the previous period.

However, like other cryptocurrencies, Bitcoin is not money in the traditional sense, and its participation in payments for goods and services only partially explains the exchange rate. There is an opinion about the increase in the cost of Bitcoin synchronously with the increase in processing power of computer equipment that directly affects the mining of cryptocurrency. Indeed, from a technical point of view, participation in the mining of new crypto coins requires the acquisition of special equipment for complex mathematical calculations. The increase in the price of Bitcoin attracts a growing number of new miners to this segment and leads to an increase in the frequency of hashing and the complexity of computations. Mining cryptocurrency is a very energy-consuming process, so miners form the so-called "mining farms" near power plants to make more enormous profits from mining. Thus, the high cost of generating new blocks in the blockchain over time smoothes the super-profits obtained by increasing the price of Bitcoin.

Due to the limited amount of maximum emission embedded in the Bitcoin software code, the need to perform more complex calculations, and the increase in energy costs for mining new crypto coins, Bitcoins are often compared with gold, which is also an exhaustive asset with high extraction costs.

In other words, we can consider cryptocurrency as a specific commodity, the mining costs of which determine the cost price. Accordingly, the estimation of the cost of cryptocurrency can evaluate the price calculation of Bitcoin.

To characterize the latter indicator, we use data on the difficulty of mining – the complexity of creating new blocks in the blockchain, which is adjusted periodically as a function of how the network of miners has deployed much hashing power. Figure 2 presents comparative data on the change in the price of Bitcoin and the difficulty of mining.

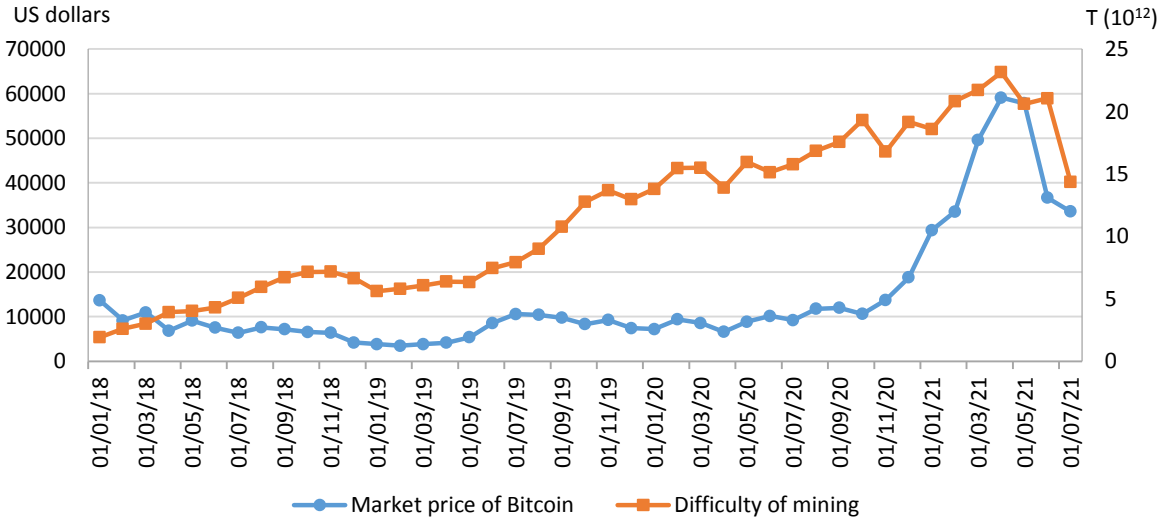

Figure 2. Comparison of energy costs for mining and Bitcoin prices

Source: formed by the authors based on data of BTC.com, CoinDesk

A Scatter plot of the Bitcoin market price and the difficulty of mining (Figure 3) demonstrate the weak linear correlation between these indicators from January 2018 to July 2021. Pearson's correlation coefficient is 0.67. However, the relationship between the studied indicators is quite accurately described by a polynomial trend. It is also worth noting that when limiting the study period from January 2020 to July 2021, the Pearson correlation coefficient increases by 0.79.

This can be explained by the fact that there was no clear linear relationship between the difficulty of mining and the price of Bitcoin in the initial stages.

The market price of Bitcoin was formed primarily based on speculative expectations. But if we take the recent periods (later than 2019), the difficulty of mining and the corresponding energy consumption for each new block in the blockchain increases, which correlates with the change in the market price of Bitcoin.

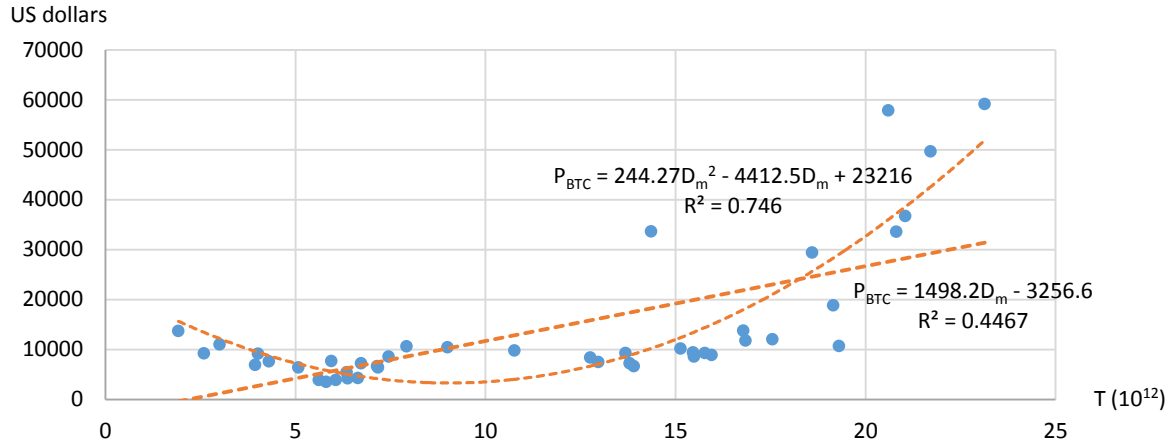

Figure 3. Correlation between the Bitcoin market price (P_{BTC}) and difficulty of mining (D_m)

Source: formed by the authors based on data of BTC.com, CoinDesk

According to the preliminary analysis results, the factors shaping the value of Bitcoin and other cryptocurrencies must be determined considering the many components. However, the principal factor in the formation of value is nevertheless a speculative factor associated with the expectations and interest of investors to acquire this asset.

Speculative operations with cryptocurrencies include the exchange transactions between cryptocurrencies and traditional currencies and the exchange of cryptocurrencies for other common cryptocurrencies – Bitcoin, Ethereum, and Ripple.

Empirical studies indicate the possibility of obtaining a significant arbitrage trading USD and EUR against Bitcoin simultaneously on different markets (Czapliński and Nazmutdinova, 2019).

Many analytical models describe the volatility of financial instruments in time.

The most common method is VaR (Value at Risk), which is generally used to measure the uncertainty of the future state of the asset. Another group of methods (e.g., RiskGrade statistics by the RiskMetrics Group) enables investors to assess the market risk accurately.

However, some of the features of cryptocurrencies make ineffective the unconditional use of standard methods of assessing the risks of traditional investment assets.

Because of the decentralized nature of cryptocurrency, their price dynamics depend more on the behavior of users - miners and participants of exchange and over-the-counter cryptocurrency trade than on objective market factors and economic preconditions.

Several studies (Garcia et al., 2014; Kaminsky and Gloor, 2014) emphasize that social networks, the media, communication media on exchanges through informational messages, and various social effects significantly impact the Bitcoin demand and their market value. For example, informational messages about the theft of cryptocurrencies from virtual wallets due

to the hacking of the Japanese cryptocurrency exchange Zaif led to a sharp short-term decrease in the market value of Bitcoins in September 2018.

Under the influence of the sentiments of the cryptocurrency market participants during periods of sharp growth in the price of Bitcoins, the interest in acquiring this cryptocurrency leads to a further rise in its price (Kristoufek, 2015). Conversely, a sharp drop in prices causes its further even greater falling.

An unreasonable increase in the price of a cryptocurrency, caused by increased demand and the desire of users to own a certain amount of such cryptocurrency, can lead to the formation of a financial bubble. The formation of a financial bubble has two stages. The first, fundamental, is the condition of the emergence of a financial bubble and characterized by the increase in capital return. The second stage is purely psychological when there is a willingness to invest profitably and earn well, which determines the size of a bubble.

One of the methods of diagnosing the emergence of financial bubbles is studying the dynamics of market growth. In a generalized form, the functional expression of capital growth and the dynamics of general economic growth is an exponential curve (Sornette and Cauwels, 2014). When prices begin to grow at a faster pace (hyperbolic growth), this is a sign of the formation of a financial bubble for this asset. Such a situation is possible when the majority of market participants are subject to the crowd effect and begin to show high activity by trying to buy as much amount of a particular exhaustible asset as possible at any price. In markets that are in the power of market makers, market principles of operation are distorted (Leonov et al., 2012).

Any price increase in such a market is not equilibrium and leads to a market collapse when it reaches its critical value. The Bitcoin market is a classic example of the emergence of financial bubbles under the influence of market participants' sentiments. During the relatively short history of the crypto market, prices have repeatedly shifted from exponential growth to hyperbolic growth with subsequent market collapse.

In December 2017, the value of Bitcoin reached a historic high of 19.5 thousand US dollars, after which it began to decline. The next critical bifurcation point was in April 2019, which was also replaced by a sharp decline in the value of the cryptocurrency.

The last hyperbolic growth of the price of Bitcoin was formed in February-April 2021, reaching a maximum price on April 14 (64.8 thousand dollars, according to Coinbase).

Over the next month, the Bitcoin price dropped almost twice. Figure 4 demonstrates a rise in the price of Bitcoin in February-April 2021 described by a polynomial function.

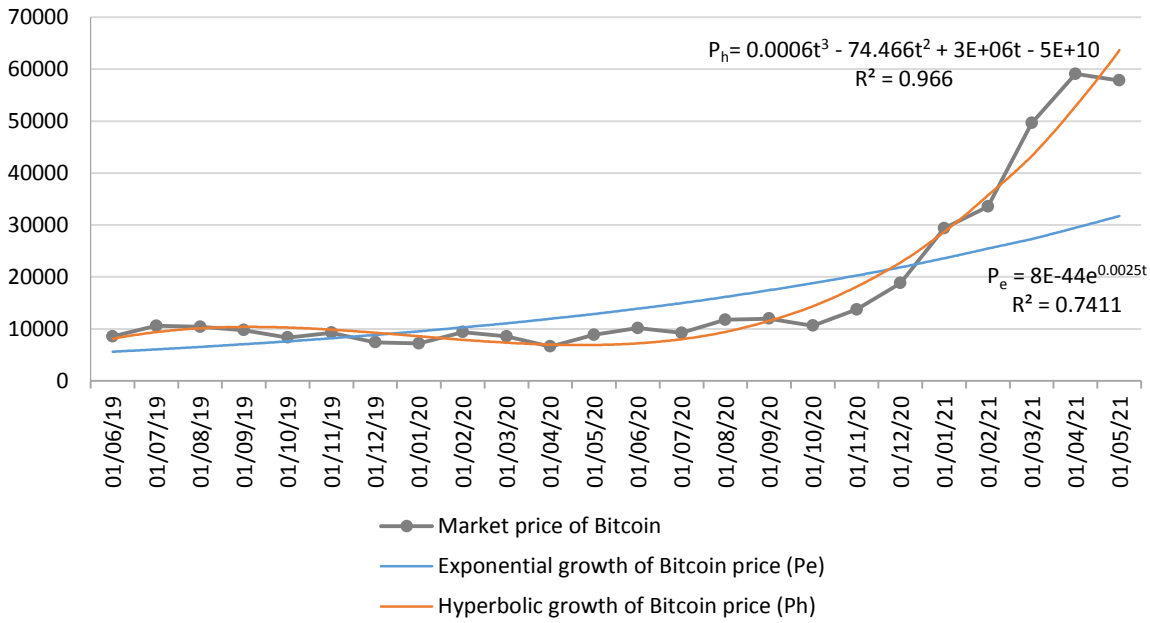

Figure 4. Signs of the formation of a "financial bubble" for Bitcoin in February-April 2021

Source: formed by the authors based on data from CoinDesk

Thus, the dynamics of the Bitcoin market price growth, which exceeds the exponential growth rate, can be considered a sign of a new "financial bubble" and a signal of a further sharp decline in the value of this cryptocurrency.

Risks of investing in cryptocurrencies

Financial risks. Based on the analysis of factors of cryptocurrency value formation, we conclude that the leading risk group for investing in cryptocurrencies is financial risks. Despite the use of Bitcoins in servicing buying and selling operations and the objective laws of forming their value depending on the complexity of calculations and the frequency of hashing, currently, the price of Bitcoin remains incomparable with the amount of its use in payment transactions and its prime cost.

Regulatory risk. All types of money in the modern economy are imperfect because they are not secured by gold or other equivalents. However, their value depends on the purchasing power and the volume of GDP created in a particular country. A central bank carries out the issue of money, taking into account the country's monetary policy and the need to maintain the stability of the national currency. It is the state that supports and guarantees the use of money as legal means of payment. Unlike traditional currencies, the circulation of cryptocurrencies is decentralized, and the central bank or other entity does not guarantee its maintenance (Vasilyeva et al., 2013). Attitudes towards cryptocurrency circulation in many countries are not yet legally regulated; therefore, there is a risk of prohibiting or restricting the use of cryptocurrencies and their depreciation since they are not legal means of payment, and the authorities do not support their stability. The task of protecting the rights of investors

engaged in transactions with cryptocurrencies is no less difficult (Alikariev and Poliakh, 2018).

Considering the impact of digitalization on society, Beyi (2018) observes that regulation of digital finance and digital mediation should be based on new approaches shaping a new economy. Cryptocurrencies differ from traditional ones on many grounds, and each of them should be considered in regulatory policy. Since the circulation of cryptocurrencies is only possible in cyberspace, the level of internet penetration and the quality of network maintenance across countries become the crucial factors of their economic progress (Milon et al., 2018; Balaraman, 2018).

Technical Risks. The emergence of cryptocurrency is associated with the introduction of innovative technology blockchain, an attractive feature of which is its security system, based on the general availability of data and their distribution between network participants. All the computers are involved in the system store a history of all transactions conducted with cryptocurrency using blockchain technology; all the records in the blocks of complete committed transactions are linked, based on data hashing, so that each block contains references to the previous one. Thus, the entire transaction database is decentralized and distributed among network members. However, it is worth noting that there is a risk of a "51% attack" on the blockchain technology since a group of participants with control over more than half of all computing power used in the system can form an alternative financial history, changing it in their favor. As a result, this version of the records will be considered truthful.

To protect against the risk of "51% attack", Bitcoin technology applies "proof-of-work" ("PoW") data protection. The algorithm for proving the work done is at the same time the principle of security of distributed systems and creating new Bitcoins (mining). This implies the need to perform some complex and long-term work (PoW-tasks) by the initiating party, provided that the other party can check it quickly and easily. Any user of the system who allows access to the power of his computer to perform complex calculations can carry out mining of new Bitcoins (Yermack, 2013). However, in conditions of the increasing complexity of hashing, more powerful equipment owned by the user gives him more chances for mining Bitcoins.

Cryptocurrency mining systems, created after the emergence of Bitcoin, instead of proof-of-work, also use other approaches to data protection. One of the most popular alternatives is the "proof-of-stake" technology (PoS, proof of ownership). With this protection method, the probability of a user generating a new block is proportional to the share of cryptocurrency units belonging to him in their total volume. Consequently, a user who owns 1% cryptocurrency can generate only 1% of all blocks. This approach minimizes the risk of "51% attack" and double-spending, as it increases the cost of monopolizing mining and complicates the accumulation of more than half of crypto coins by one person.

Additionally, the generation of blocks through the proof-of-stake does not create additional load on the processor, reducing energy costs. In contrast to mining, forming new blocks by the proof-of-stake method provides "forging" crypto coins. For the formation of a new block, the user receives a commission fee, which includes a payment for conducting all transactions in the block.

The existing cryptocurrencies differ in the encryption algorithms used, the nature and conditions of the issue, the principles of protection against abuse. These factors can significantly affect the mining and exchange rates for such cryptocurrencies and the risks of investing in the cryptocurrencies. Table 2 describes these factors for their more detailed analysis.

Table 2. Technical risk factors of investment in cryptocurrencies

Technical features of cryptocurrency	**Examples**	**The impact of the characteristics on the risk of investing in cryptocurrency**
The principle of protecting the system	PoW: Bitcoin, Bitcoin Cash, Ethereum, Litecoin, Monero; PoS: Cardano; DPoS: EOS	The application of the principle of PoW makes mining new crypto coins too expensive, which provides reliable protection against the risk of "51% attack", that is, from seizing control of crypto coins by one miner. Approaches like PoS and DPoS provide higher energy efficiency of mining while maintaining a high level of protection against the risk of "attack 51%"
Hash function cryptographic algorithm	SHA256: Bitcoin, Bitcoin Cash; Ethash: Ethereum; Scrypt: Litecoin; Ouroboros: Cardano; CryptoNight-V7: Monero	The hash algorithm creates a binding to the user's private key, which saves cryptocurrency ownership data. Currently, all of the used hashing algorithms provide a high level of reliability; their breaking at the current level of technology is impossible
Limitation of the issue volume	Limited: Bitcoin, Bitcoin Cash (21 mln); XRP (100 bln); Litecoin (84 mln); Cardano (45 bln). Unlimited: Ethereum, EOS, Stellar, Tether, Monero	Limitation of the maximum volume of cryptocurrency emissions can additionally stimulate users to buy cryptocurrency, further developing the financial bubble and increasing the investment risk

Source: formed by the authors based on Bitcoin.com, Barchart

Consequently, the current level of development of blockchain technologies, which forms the basis of existing cryptocurrencies, provides a high level of protection against the risks of unauthorized actions. Although the encryption mechanism used in cryptocurrencies circulation creates a high level of security, it does not guarantee the preservation of cryptocurrency in online wallets. Since cryptocurrencies operate exclusively in cyberspace, they can be stolen from online wallets or withdrawn from cryptocurrency exchanges through cyber attacks. At the same time, more popular cryptocurrencies, such as Bitcoin, with the highest level of market capitalization and the volume of daily trade deals, are more attractive to cyberattacks since they can provide a higher reward to their new owner. Thus, during 2020, Atlas VPN recorded 122 blockchain-linked attacks, which caused losses amounting to almost $3.78 billion (AIT News Desk, 2021). Hacker attacks on cryptocurrency exchanges and hacking of online wallets are not, in fact, cryptocurrency hacking. Thus, cryptocurrency

technology is highly reliable, but virtual wallets, where users store their private keys, do not always provide a sufficient level of security.

Conclusion

When determining the cost factors of cryptocurrencies, it is necessary to take into account many components. The analysis, carried out based on the generalization of the features of the essence and practical use of cryptocurrencies, showed that the main factors of the formation of the cryptocurrencies value are: the volume of emissions, the use of cryptocurrencies as an exchange medium, the cost of mining, and speculative factor. Among them, the critical factor in the formation of the value of cryptocurrencies is the speculative factor associated with the expectations of investors and their interest in acquiring the asset.

This paper has investigated the risks of investing in cryptocurrencies regarding financial, regulatory, and technical risks. The financial risks of investing in cryptocurrencies are related to their differences from traditional money. The mining of cryptocurrencies does not involve control and regulation by the central bank but depends on the computing capabilities of the equipment used. As a financial asset, cryptocurrencies can be a "financial bubble" because their price is incomparable with the amount of their use in payment transactions and the cost of mining. Still, it most of all depends on the behavior of participants in the crypto market. On the other hand, given the emergence of cryptocurrencies as a phenomenon of information economy and Industry 4.0, the paper analyzes the impact on the risk of investing in cryptocurrency of their technical characteristics: the principle of protecting the system from abuse; a cryptographic hashing algorithm; limitation of the volume of cryptocurrency emissions. The technology laid in cryptocurrencies is highly reliable; still, there are significant risks associated with breaking into cryptocurrency exchanges and virtual wallets that store the private keys of cryptocurrencies users.

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Conflict of interest

The authors declare that no competing financial interests or personal relationships that could influence this paper exist.

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