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The Dynamics of Cryptocurrency Price Volatility in the Face of the Crisis on the Example of Bitcoin and Ethereum

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Abstract

Theoretical background: Over the years, investing in cryptocurrencies has become very popular, and until recently, investors have predicted Bitcoin as a "safe haven". Belief in a decentralized virtual currency even prompted the Salvadoran government to recognize Bitcoin as a legal tender in September 2021. However, cryptocurrency has depreciated significantly since then. The high amplitude of the fluctuations shows that on November 10, 2021, Bitcoin hit an all-time high of USD 68,979, and on June 18, 2022, it fell to its low of USD 17,601. Today, investors are wondering if investing in Bitcoin and other cryptocurrencies still make sense.

Purpose of the article: The aim of the article is to compare the price fluctuations of the most popular cryptocurrencies, i.e. Bitcoin and Ethereum in the currently observed economic crisis in the world and the collapse of the cryptocurrency market.

Research methods: Observations of the cryptocurrency market and theoretical issues of its functioning were combined with the analysis of empirical data of Bitcoin and Ethereum quotations from January 2022 to June 2022. The basic research instruments were based on the analysis of dependencies and descriptive statistics. The conducted analysis of the time series was aimed at detecting the nature of the studied phenomenon represented by the sequence of observations of daily quotations and forecasting future values of the time series. In this context, the course of Bitcoin and Ethereum quotations was examined in two categories: Close and Market Cap in search of a potential development pattern.

Main findings: The conducted research shows that strong and unpredictable fluctuations in the prices of the studied cryptocurrencies, especially in the period of market shocks, imply unknown uncertainty, much more important than investment decisions made under the conditions of measurable risk. Cryptocurrencies cannot function as an alternative to gold, enabling value to be stored, as confirmed by market quotations over the past months.

Introduction

Until recently, investing in cryptocurrencies was a popular direction, and owning Bitcoin was a dream of many investors. However, recent significant sell-offs caused by sharp price drops have raised concerns about the future of this market, even though investors had predestined Bitcoin as a "safe haven" in times of crisis a few months earlier. The belief in a decentralized virtual currency immune to market turbulence even convinced the Salvadoran government to recognize Bitcoin – in September 2021 – as legal tender. Since then, however, the cryptocurrency has depreciated considerably, although Salvador's president, Nayib Bukele, predicts a rebound after a downturn.

Given the continuing downward trend, investing in Bitcoin is becoming extremely risky. Adding to this the shutdown of the South Korean cryptocurrency exchange, which caused the price to drop further from USD 20,000 to USD 11,000, uncertainty among investors is exacerbated. Disappointed investors and market watchers are contemplating the continued sense of investing in Bitcoin and other cryptocurrencies. They ask about risks and prospects. Why is the Bitcoin price falling? Will the downtrend stop and when? They come to these conclusions by observing the drastic decline in cryptocurrencies, with the market-leading Bitcoin currently trading at its lowest level in 18 months, more than 60–70% below its record level. The underlying value of cryptocurrencies is difficult to quantify due to the lack of cash flow data.

Research on the effectiveness of cryptocurrencies usually focuses on individual values and their comparison, and investors look for answers to the above questions, which would help them make the right decisions in the future.

The recent period of extremely high downward volatility of cryptocurrencies shows that this market is struggling with a decline in confidence in digital assets and decentralized financial services, independent of the banking system, promoted in 2021. There is no doubt that in trading, the greatest profit opportunities can be found where there is the greatest volatility. Currently, the market is testing the sensitivity, or rather the propensity of investors, to extreme risk, but crypto enthusiasts still see a future for this type of asset. The events strongly related to the pandemic crisis (from 2020) and the military conflict in Ukraine (from 2022) affect financial markets, especially such as Forex and Cryptocurrencies, which are sensitive to high amplitude fluctuations. Loud media messages regarding the decline in cryptocurrency prices and the predictions of the crypto strategist "Kaleo" (Smith, 2022) announcing Bitcoin's return to the growth path in 2023 and reaching record prices in the years 2024–2025 encourage the conduct of multifaceted experimental empirical research.

In this context, the authors examined the Bitcoin and Ethereum quotes in two categories: Close and Market Cap, to look for a potential development pattern. Based on empirical data, an analysis of the location, variability, and dependence of the quotations of these two leading cryptocurrencies in terms of value was carried out. The length of the time series was conditioned by a deliberate left-hand limitation to the level of rates coinciding with the quotations of June 2022.

The epistemological nature of the article is part of a literature review, observation of current changes and trends in the cryptocurrency market, analysis of opinions formulated by analysts-practitioners, formal and legal decisions regarding virtual currencies, and a relational-index analysis of Bitcoin and Ethereum time series quotations in the two above-mentioned categories: Close and Market Cap from January 2021 to June 2022.

Literature review

The literature on the subject to date indicates a multifaceted approach to cryptocurrency market research and covers various macroeconomic and technical factors helpful in studying the volatility or valuation of cryptocurrencies. In the case of a highly speculative instrument like Bitcoin, investor behavior plays an important role in asset valuation. The latest work focuses on researching the effectiveness of the cryptocurrency market and individual coin values, returns on investment, and asset valuation (Dunbara & Owusu-Amoakob, 2022). The analysis concerns the Bitcoin price strongly reacting to shocks in monetary policy (Ma et al., 2022) and the strong ties between Bitcoin and local stock markets (Bao et al., 2022). Ma and Luan (2022) investigated the synchronization of Bitcoin and Ethereum cryptocurrencies

dependent on Bitcoin's upward volatility and showed that when the upward volatility is high, Ethereum's synchronicity has a significant positive impact on the risk of a Bitcoin crash. In turn, Kumar (2022) analyzed the so-called turn of the month (TOM) effect in Bitcoin, Ethereum, and Litecoin cryptocurrencies from August 2015 to August 2021 and the results obtained showed that returns from TOM are positive and much higher than returns unrelated to TOM. Moreover, the TOM effect is not driven by the day of week (DOW) effect or the January effect. Qadan et al. (2022) also dealt with the seasonal and calendar effects as well as the price effectiveness of cryptocurrencies. In contrast, Lopez-Martin (2022) tested the random walk hypothesis for leading cryptocurrencies. Particularly important seems to be the study of cryptocurrencies in the period of market shocks related to the economy, inflation, sanctions, and armed conflicts showing the sensitivity or neutrality of cryptocurrencies to global events and their impact on investment returns (Przyłuska-Schmitt et al., 2022; Foroutan & Lahmiri, 2022). Research is also carried out on the aspect of concerns about the safety of cryptocurrency use (Quamara & Singh, 2022), as well as the interrelationships between media attention and cryptocurrency markets. The use of transfer entropy to measure information flows between cryptocurrencies was applied by Assaf et al. (2022) and also by Neto (2022), for whom transfer entropy was used to detect external effects between movements in cryptocurrency prices and the media attention on this market.

This research is part of the current cryptocurrency market analysis. The authors focus on studying changes in the quotations of the two largest cryptocurrencies, Bitcoin and Ethereum. This publication will allow investors to look once again at the cryptocurrency market from a critical point of view, enriching their knowledge with a new market analysis that is used to detect spillovers between cryptocurrency price movements and media attention.

Research methods

The observations of the cryptocurrency market and theoretical issues of its functioning, combined with the analysis of empirical data, show that the cryptocurrency market is not only risky but even uncertain. Uncertainty occurs when the probability of future events is undefined or impossible to calculate (data necessary to calculate is missing). In contrast, risk, as opposed to uncertainty, is a phenomenon where probability is measurable. Therefore, the theoretical approach is mainly based on market observation and stakeholder behavior.

The research material in the empirical part consists of time series of Bitcoin and Ethereum quotations from January 2021 to June 2022 in two basic categories: Close and Market Cap: C_{BTC}, C_{ETH}, MC_{BTC}, MC_{ETH}. The subject of the analysis was also the differences in the daily quotations in terms of direction and intensity. The adopted time limit was conditioned by the deliberate selection of the left-hand range of quo-

tations similar to the level of June 2022. The price convergence determined by the quotations recorded on June 30, 2022, in the case of Bitcoin, is on December 15–16, 2021, and in the case of Ethereum – on January 6–7, 2022. Empirical data was generated from the Coinmarketcap portal (https://coinmarketcap.com). The basic research instrumentation used for empirical data was based on the analysis of dependencies (Pearson's correlation coefficient, chi-square test of independence, contingency coefficients: Kendall's tau-b and Kendall's tau-c) and descriptive statistics. Due to the multiple disproportions of the values that make up the individual time series C_{BTC}, C_{ETH}, MC_{BTC}, MC_{ETH} they were normalized (x_{max}=100) This transformation allowed for the visualization of the analyzed data. The research process was subordinated to the verification of the following research hypotheses:

H1: Bitcoin, promoted by fans of digital assets as a "safe haven" in times of crisis, has no justification, and its limited supply is not a sufficient argument for its increases.

H2: Cryptocurrencies as risky digital assets depreciate in the first place as investors' emotions weaken due to increased extreme risk.

H3: Bitcoin and Ethereum prices fluctuate statistically convergingly over time.

H4: Bitcoin and Ethereum market capitalizations change over time in a statistically consistent way.

H5: There is no directional consistency between Bitcoin and Ethereum daily quotes.

Results

Investing in cryptocurrencies, especially in the initial period of its development, brought many investors huge profits with a relatively low capital commitment, while others had severe losses. Proponents of investing in cryptocurrencies consider this market to be promising, with monetary benefits, assets of the future, and even the epitome of freedom. They see Bitcoin itself as a way to store value, comparing it to "digital gold", the purpose of which is to protect your property from losses, the so-called "safe haven". Cryptocurrency opponents see them mainly as a treasury for speculators, worthless and useless assets, and even financial pyramids.

The Bitcoin market has been around for 13 years and this is a period in which the virtual currency has experienced crashes and declines but still maintains an overall upward trend. Observations of the market and investor behavior over the past year (Figure 1) show that Bitcoin has significantly decreased from its record level of USD 69,000 in November 2021, with the downward trend accelerating twice (in November 2021 and then in March 2022), including the failure of Terra, the failure of DeFi's major lender Celsius, and the global rise in inflation. Ethereum is following almost the same trend. The only, but very important difference between the most popular cryptocurrencies is their price. One Bitcoin is currently around USD 20,895 and one Ethereum is USD 1,381. Thus, the discounts on the cryptocurrency market indicate a significant loss of Bitcoin holders compared to Ethereum holders.

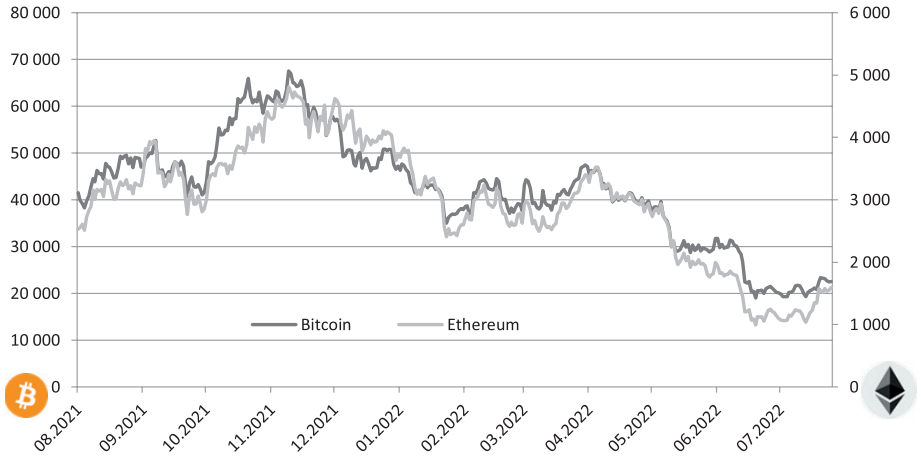

Figure 1. Bitcoin and Ethereum prices in the period August 2021 – July 2022 in USD

Source: Authors' own study based on (CoinMarketCap, n.d.).

The recent increases in the value of Bitcoin (Figure 2) and its resistance to market turmoil have prompted some investors to take out loans or credits to buy the desired digital currency (Debthammer, 2022). Even the government of El Salvador, which bought Bitcoin last year shortly before significant drops, has succumbed to the temptation of promising profits and good media press. In the current situation, the investment strategy undertaken by the government of Salvador is criticized. However, Finance Minister Alejandro Zelaya explains that the country's budget has not been lost due to the sharp drop in Bitcoin's exchange rate, as the government has not sold its holdings, so it has not realized a loss. Salvador currently owns 2,301 Bitcoins worth around USD 50 million, which is less than half of the cash that the government invested in purchasing Bitcoins in October 2021 and May 2022, when Bitcoin were worth USD 60,300 and USD 30,700, respectively (Attlee, 2022).

Another example of the acceptance of digital currency is Ukraine. The Ukrainian government appealed to the crypto community to raise funds to support civilians and soldiers in the war with Russia. The truth of the information was confirmed by the minister of digital transformation, Mykhailo Fedorov, who announced on Twitter that the country also accepts international aid in the form of cryptocurrencies, Bitcoin, Ethereum, and Tether (Sarkar, 2022). Funds worth over USD 100 million were likely raised in this way (The Conversation, 2022). Crypto entrepreneur Vitalik Buterin, a co-founder of Ethereum, has expressed suspicion that accounts requesting cryptographic donations to Ukraine have been hacked. But the American diplomat Tomicah Tillemann confirmed their ID with the Ukrainian ambassador Olexander Scherba (Sarkar, 2022). As the West continues to impose further sanctions on Russian banks, Mykhailo Fedorov has also called for sanctions against Russia's cryptocur-

rency holdings. To this end, he appealed to global cryptocurrency exchanges to block the addresses of Russian users. He stressed that the exchanges should freeze not only addresses officially related to Russia and Belarus but also "sabotage ordinary users". As a result of this appeal, crypto exchanges are considering cutting off the Russian Bitcoin system, with some platforms freezing accounts linked to Russia and Belarus. So far, only Binance has refused to join this appeal, claiming it will not block the cryptographic assets of innocent Russians (Partz, 2022).

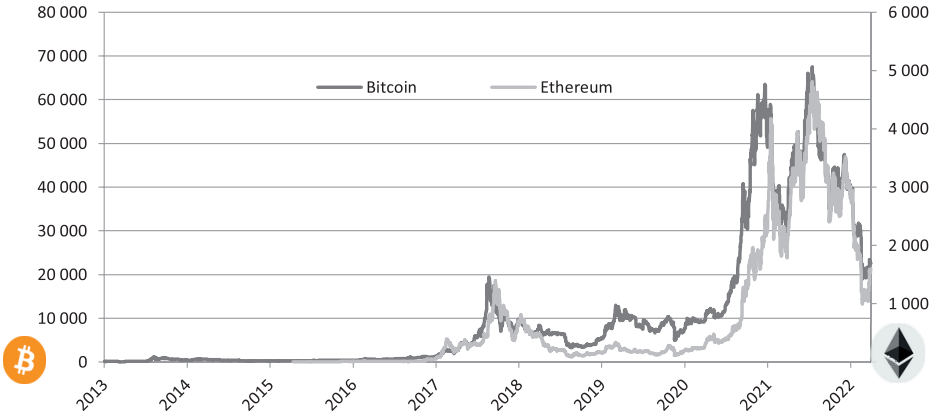

Figure 2. Bitcoin (2013–2022) and Ethereum (2015–2022) quotes in USD

Source: Authors' own study based on (CoinMarketCap, n.d.).

It follows the decentralized digital currency system is not free from sanctioning and taking a position in political matters of the world, and yet one of the highlighted features, considered as the crown advantages of Bitcoin, was the elimination of the possibility of sanctioning system users. Bitcoin also cannot be a "safe haven" during the crisis, as the deep depreciation observed in recent months, in the face of the global crisis and rising inflation, as well as international armed and food tensions, show that it is following a downward trend. Hence, cryptocurrencies are significantly risky digital assets that depreciate in line with the global macroeconomic situation. Stakeholders' actions weaken both as a result of increased extreme risk as well as limited and costly access to external sources of financing for this desired investment through loans and credits.

The results of the statistical analysis shows the course of the normalized time series C_{BTC}, C_{ETH}, MC_{BTC}, MC_{ETH}, which indicate a fairly high level of convergence. In particular, attention should be paid to the very high dependence in the period from January 7, 2021, to June 30, 2022. The highest Bitcoin quotations were recorded on November 8, 2021, and Ethereum – on November 4, 2021 (Figure 3).

Figure 3. Standardized time series of Bitcoin and Ethereum quotations by Close and Market Cap categories in the period January 2021 – June 2022

Source: Authors' own study.

The correlation analysis determined on the empirical series C_{BTC}, C_{ETH}, MC_{BTC}, MC_{ETH} indicates the presence of high and very high dependence between all matched pairs (Table 1). By shortening the analyzed time series to the period 7 May 2021 – 30 June 2022, the strength of the relationship increases. This simulation resulted from the emergence of a clear convergence of all four analyzed time series.

Table 1. Pearson correlation results (time series January 2021 – June 2022)

Pearson Correlation	C_{BTC}	MC_{BTC}	C_{ETH}
MC_{BTC}	1.000** (1.000**)[a]		
C_{ETH}	0.628** (0.872**)[a]	0.645** (0.876**)[a]	
MC_{ETH}	0.612** (0.861**)[a]	0.630** (0.867**)[a]	0.999** (0.999**)[a]

** correlation is significant at the 0.01 level (2-tailed). For each pair $p < 0.001$.

[a] results obtained on a shortened time series covering the period 7 May 2021 – 30 June 2022

Source: Authors' own calculations in SPSS.

The graphical presentation of the C_{BTC}, C_{ETH}, MC_{BTC}, MC_{ETH} time series and results of the correlation analysis indicate the presence of a high convergence of the listed features. Meanwhile, taking into account the binary statement based on daily increases (↑) and decreases (↓) it turns out that the convergence occurred in less than 50% of the pairs (↑: 25.6%; ↓: 23.6%). The simulation based on the combination of the

Bitcoin variable versus the Ethereum delayed variable returns higher compliance rates for $n-5$: 54.7% (↑: 23.5%; ↓: 21.8%) and $n-6$: 54.8% (↑: 23.3%; ↓: 21.9%). During the analyzed period, Bitcoin was slightly declining (4: 0.7%), and Ethereum was increasing (26: 4.8%). The highest daily price change for Bitcoin was recorded on May 15, 2021, and amounted to 41.9%, and in the case of Ethereum on May 19, 2021, and amounted to 76.1%. In both cases, it was a decline. In general, however, the time series: C_{BTC}, C_{ETH}, MC_{BTC}, MC_{ETH} are characterized by very high dispersion. The random volatility coefficients determined for both cryptocurrencies indicate the average volatility, lower in the case of Bitcoin.

The test statistics obtained in the chi-square test of independence and the designated Kendall's tau-b and Kendall's tau-c symmetrical measures, respectively, in the contingency analysis do not give grounds for stating the existence of a statistically significant relationship: $x^2=0.112$, $p=0.738$; $\tau b=-0.014$, $p=0.738$; $\tau c=-0.014$, $p=0.738$. The obtained results indicate a very poor mutual compliance of the orderings of the listed features with the annotation of the opposite direction of the interaction.

As a result, they do not negate the fact that there is a statistically significant relationship in the quotation levels of the cryptocurrencies listed. The lack of daily compliance in the direction of Bitcoin and Ethereum price changes ultimately leads to a similar price effect in the following days.

Discussions

In the face of the weakening world economy, high inflation and tightened monetary policy are putting a strain on the demand of enterprises and consumers. Markets are focused on the United States, where the international trading currency, the dollar, has been strengthened by the Federal Reserve and interest rates have been raised to cool inflation, which in June 2022 reached its highest level in 40 years. Crypto is in the midst of one of the worst market crashes a relatively new industry has ever witnessed. Since the peak of last year's boom, the most popular cryptocurrencies, such as Bitcoin and Ether, have fallen by around 70%, while the size of the industry itself has dropped from over USD 3 trillion to less than USD 1 trillion. As it turns out, cryptocurrency is an asset class influenced by the broader macroeconomic environment, and the decline in digital asset prices has discouraged many industry stakeholders, including lenders, stablecoin issuers, and retail and institutional investors (Chipolina & Samson, 2022).

So, there seems to be a paradox at the heart of cryptocurrencies like Bitcoin. Originally, they were advertised as an alternate currency that could be used in everyday transactions. However, their price is too volatile to be used in a transactional manner. In turn, if the price stabilized, it would not appeal to speculative investors, most of whom were attracted by the promise of quick wealth. The suggestion that

cryptocurrencies can function as an alternative to gold to overcome declines in stock markets has been dispelled in the last few months.

The discussion around the future of cryptocurrencies is difficult due to the very high level of volatility of the cryptocurrency market combined with the unpredictability of quotation levels and the behavior of market participants. The available scientific works on cryptocurrencies are characterized by a high level of uniqueness due to the relatively new subject matter, the very fast development of the cryptocurrency market, and the interdisciplinary nature of the product, technical, service, formal and legal. The complexity of the issues combined with the rapid evolution of artificial intelligence and the increasing creativity of all stakeholders in the cryptocurrency market defines a very wide research spectrum focused on both classical analyses and scientific experiments.

Cryptocurrency prices are characterized by sharp and high fluctuations. Many investors who believe in fast and big profits are currently focused on buying cryptocurrencies, assuming that current prices are low. However, the assumed optimism cannot be linked with certainty. The cryptocurrency market is still unexplored territory, for which extrapolation is very difficult and, by definition, is subject to a large *ex-post* error. The lack of long-term trends in combination with a large group of stakeholders, including many investors, does not provide a formal basis for constructing reliable patterns of potential changes.

The identified convergence of the daily price level of the researched cryptocurrencies is consistent with, *inter alia*, the issue of price efficiency. The results of the research carried out indicate the existence of few similar effects in this respect as opposed to traditional assets (Lopez-Martin, 2022), except for the within-the-month effect (Qadan et al., 2022). In this field of research, analyses are also available to indicate the turn-of-the-month effect (Kumar, 2022). Our research allows us to refine the above theses about Bitcoin and Ethereum, where the within-the-day effect has been identified. The synchronicity of both cryptocurrencies is confirmed by research focused on the analysis of risk and price increases (Ma & Luan, 2022). The shaping of the market based on the two major cryptocurrencies is subject to similar fluctuations over time.

Even though in the case of a highly speculative instrument created by cryptocurrencies, the behavior of investors plays an important role in the valuation of Bitcoin assets, which is considered a safe resource in periods of high volatility (Lee & Rhee, 2022; Przyłuska-Schmitt et al., 2022). Ruchir Sharma, president of Rockefeller International, assumes that the soon-to-be elimination of speculators from the cryptocurrency market will result in the strengthening of Bitcoin as a realistically stable asset (BitHub, 2022). The analyst predicts that Bitcoin will recover, as did Amazon, after very high volatility, and will replace the dollar in the future. The fact is, there are serious discussions today about the introduction of digital currencies and the total withdrawal of cash from the market. However, these plans should be assessed as visions that require a much greater cognitive, formal and legal ordering of the crypto-market.

Investors who have been driven by the magic of fast and big profit still believe in the power of cryptocurrencies. Many, especially relatively young Internet users behave similarly. The belief in earning money by clicking on certain content on the Internet are publishing photos and videos is more and more common. If there are no investment measures at stake, in the case of failure, these endeavors may at best be accompanied by disappointment. However, the fact that since November 2021 the price of Bitcoin has fallen by more than 70% and Ethereum by more than 75%, it had a real impact on the portfolios of investors, many of whom took out loans for this purpose.

Conclusions

At a time of such a huge sell-off and the worsened sentiment of cryptocurrency investors, which is headed in an unknown direction, it may sound a bit cliche, but there are interesting applications of this blockchain technology in the real world. One example is the UK asset management industry which is interested in the tokenization of funds to lower back-office costs. In turn, JP Morgan uses blockchain and its token for repo transactions during the day, and many companies outside the financial sector are testing digital ledgers for record keeping. There are also other solutions, such as the FTX (cryptocurrency derivatives) proposal to change the way futures trading works in the US, which is also extremely interesting. It is hard to say right now whether it is better or worse than the current system, but it is one of the clearest examples of how crypto technology can transform a key part of the financial markets.

Due to the bad mood in the cryptocurrency market, the Bitcoin trading volume in the first quarter of 2022 turned out to be two and a half times lower than in the first quarter of 2021. Investor interest in the largest cryptocurrency by market capitalization has plummeted, as has trading volume, which in the first quarter of 2022 was approximately USD 2.42 trillion. It was a decrease of 60% to the volume of trading recorded in the corresponding period of 2021. Currently, as of 25 July 2022, Bitcoin's capitalization is USD 420.14 billion, and Ethereum is USD 186.83 billion (https://coinmarketcap.com).

However, this potential adoption may be reduced through the uncontrolled fragility of market conditions and the increase in potential modern security concerns. The state-of-the-art mechanisms that constitute the core concept of cryptocurrencies, as well as the various applications of cryptocurrencies, constitute a detailed study of various contributions from the literature on the security aspects of cryptocurrency use. Multifaceted considerations regarding cryptocurrencies and new projects related to them emerging all over the world imply a wide interest in this issue on the part of investors, entrepreneurs, banks, and governments interested in their practical use, which opens another chapter of challenges for prospective directions of research in this field.

Historical data on prices of the market-leading cryptocurrencies is a set characterized by high dispersion. The identified dependencies do not exhaust the signaled

research problem in the search for model solutions allowing for forecasting to meet the statistical acceptability criterion. The practical conclusion is that Bitcoin and Ethereum prices are relatively identical over time, albeit with a disagreement with the daily declines and rises. The obtained results in the empirical part have practical implications for all stakeholders of the cryptocurrency market, in particular for potential investors. Regardless of the investment successes that have taken place in the cryptocurrency market so far, one should be very cautious about investing funds in these relatively new, and in practice still unknown, assets.

Knowledge about the cryptocurrency market is inscribed in the rich scientific achievements, but global economic problems, very large fluctuations in the rates of individual cryptocurrencies, and finally statistical predictive uncertainty are the premise for conducting further theoretical and practical research, including scientific experiments on empirical data. The new and dynamically changing cryptocurrency makes a great impression on a large part of the global community. People lured by the prospect of quick and large profits, recorded in information and marketing materials, often devoid of scientific evidence, do not always make rational investment decisions.

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