

## THE LINK BETWEEN RETURN AND RISK IN THE CASE OF BITCOIN

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### **ABSTRACT**

*Over time, cryptocurrencies have experienced a widespread adoption, with bitcoin emerging as the most prominent example. In an increasingly uncertain world, the significance of possessing a stable store of value, traditionally fulfilled by gold, has escalated. Bitcoin has been often referred to as a digital equivalent of gold. Hence, this study primarily focuses on analyzing the price dynamics of this particular cryptocurrency. A comprehensive literature review will be employed to examine the regulatory obstacles encountered within the cryptocurrency market. Additionally, considering the contentious nature of this field, special attention will be devoted to the clash of perspectives surrounding this innovation. Subsequently, concentrating on the period 2016-2021, this paper will investigate the factors that define a risk-weighted investment, utilizing the Sharpe ratio and Sortino ratio. However, there has been significant volatility in the price of Bitcoin in 2020-2021, and our research fills a gap in the relationship between Bitcoin returns and risk in the post-2016 period. Overall, the analysis concludes that bitcoin exhibits highly turbulent investment characteristics. Despite its substantial price appreciation, the findings indicate that bitcoin displays significant volatility. Consequently, selecting this investment alternative entails considerable risks. Based on our results, there were years between 2016-2021 when bitcoin was a good investment, but in most cases its returns were associated with excessive volatility and risk. For this reason, it is not recommended for risk-averse rational investors.*

Keywords: Bitcoin, return, risk, cryptocurrency

### **INTRODUCTION**

Bitcoin is a digital currency that operates on a decentralized network called the blockchain. It was created in 2009 by an anonymous person or group of people using the pseudonym Satoshi Nakamoto. Bitcoin is often referred to as a cryptocurrency because it uses cryptographic techniques to secure transactions and control the creation of new units. (Nakamoto, 2008). It is not governed by central authorities, such as governments or central banks, and intermediaries for currency issuance or settlement and validation of transactions, and can provide lower transaction fees for payments (Ali et al., 2014) In Hungary, cash payments are dominant, although digital solutions are gaining ground (Pintér et al., 2021, 2022; Menrad & Varga, 2020). Cryptocurrency payments are negligible.

There are multiple perspectives regarding bitcoin. Devoted proponents assert that it possesses the potential to supplant the role traditionally held by gold as an investment. Conversely, critics contend that bitcoin lacks intrinsic value, its source code is replicable, and it is unable to fulfill the functions of a currency, although electronic money is also able to fulfill all money functions. (*Gál & Gáspárné, 2013*)

Bitcoin currently holds a substantial portion of market capitalization within the realm of cryptocurrencies. Consequently, fluctuations in its price exert a noteworthy influence on the prices of other cryptocurrencies. Hence, the present study aims to analyze and compare the returns and risks associated with bitcoin. In pursuit of this objective, the research employs the Sharpe ratio and Sortino ratio to examine the investment viability of bitcoin, alongside tracing the evolution of its price.

Within the realm of cryptocurrencies, a significant aspect of concern pertains to the regulatory challenges associated with criminal activities. The presence of anonymity renders the market substantially appealing to illicit actors. Regrettably, within the dark web, operators cannot ascertain the precise identities of participants with 100% certainty. Nonetheless, a positive consequence emerges whereby investigators and agents can assume undercover roles, thereby bolstering the likelihood of apprehending criminals. Furthermore, by employing adequate expertise to scrutinize the transaction chain of the blockchain, comparable insights into the criminal network can be obtained, akin to examining traditional financial data.

However, these favourable attributes solely apply to the initial generation of cryptocurrencies, namely Bitcoin. Subsequent generations such as Monero and Zcash have been developed, which possess the capability to obfuscate the transaction chain through various means, rendering it untraceable.

Overall, the European Union (EU) encounters a dearth of regulatory measures in this domain. Anonymity and decentralization serve as impediments to facilitating effective regulation (*Teleki, 2020*).

The cryptocurrency market is additionally characterized by its illiquidity and extreme volatility. (*Wang et al., 2016; Ciaian et al., 2018; Corbet et al., 2019; Gil-Alana et al., 2020; Mba & Mwambi, 2020; Fang et al., 2021*). The pronounced market volatility exposes investors to elevated risk levels, which may engender significant profits or substantial losses. Consequently, investors necessitate the requisite tools to effectively manage and incorporate these dynamic volatility dynamics. (*Mba et al., 2018; Mba & Mwambi, 2020*).

*Liu et al. (2022)* results show that the cross-section of cryptocurrencies can be meaningfully analyzed using standard asset pricing tools. Moreover, a parsimonious three-factor model that can be constructed using the market information is successful in pricing the strategies in the cryptocurrency market.

Interestingly, the cryptocurrency market appeared as a risk management tool for the domestic and international investors of stock and commodity markets around the globe, particularly during the period of higher uncertain events (*Al Mamun et al., 2020; Ariefianto, 2020; Bouri and Gupta, 2019; Cheema et al., 2020; Colon et al., 2021; Lucey et al., 2021; Matkovskyy et al., 2020*)

There are varying perspectives on the perception of bitcoin. With its increasing popularity, more investment funds are venturing into the development of crypto-

asset-based products, a financial activity that necessitates regulation. Consequently, it is likely that the freedom characterizing the cryptocurrency market will undergo changes in the near future. However, bitcoin mining represents a significant waste of energy (*Vranken, 2017*)

György Matolcsy, President of the Hungarian Central Bank, advocates for the prohibition of cryptocurrency mining and trading within the European Union (EU). This aligns with the viewpoint of the EU's primary financial regulator, who contends that is susceptible to numerous abuses, and its proliferation necessitates regulation. The prominent issue at hand is the substantial energy wastage associated with mining, a concern that the world has been endeavoring to mitigate for years due to climate protection reasons. In the midst of the ongoing energy crisis, mining exacerbates the situation. To alleviate the burden on the public, the government is temporarily reducing electricity prices, which can be exploited by bitcoin miners. In the absence of the cost of mining exceeding the value of bitcoin, the market itself cannot rectify this problem. Consequently, Matolcsy finds it entirely comprehensible to restrict or even ban such activities.

The Hungarian National Bank also states in its article that many individuals perceive cryptocurrencies as pyramid schemes, an issue that Matolcsy believes should be preempted to prevent potential economic problems and general social discontent resulting from individuals losing their money. Furthermore, he highlights two additional concerns: the absence of investor protection and the potential for criminals to exploit cryptocurrencies for extortion and money laundering purposes. For instance, criminals may demand bitcoins in exchange for the return of stolen data. Hence, regulating this market becomes crucial both in terms of energy consumption and in order to prevent individual and economic complications (*baon.hu, 2022*).

Géza Sebestyén's blog discusses the „Snapchats of the financial sector.” In 2016-2021 years, numerous innovators, including bitcoin and thousands of other cryptocurrencies, have emerged within the financial market. Sebestyén identifies several issues associated with these innovations, such as fraudulence, unviability, and their limited suitability for large-scale financial transactions in urban settings. Moreover, he notes that during the time of the Crown Tax, anonymity, while considered a positive feature, tended to aid fraudsters. Sebestyén acknowledges one aspect of bitcoin that its proponents have rightly emphasized, namely its transfer speed. Indeed, cryptocurrencies have enabled faster money transfers compared to traditional monetary systems. However, traditional operators have incorporated this feature into their own systems. Hence, it can be inferred that central banks have responded to the challenges posed by virtual currencies (*Sebestyén, 2021*).

On the other hand, billionaire founder and chief investment officer of investment firm Miller Value Partners, Bill Miller regards bitcoin as „insurance against financial disaster”, and has allocated 50% of his wealth to cryptocurrency. Miller believes that its decentralization represents its greatest advantage, safeguarding against hyperinflation and nationalization in unstable economies. In a podcast episode titled “Richer, Wiser, Happier” on May 24, 2021, Miller cited the collapse of the financial system in Afghanistan as an illustrative example. When the United States withdrew from Afghanistan in August 2021, it became impossible to

transact between the two countries using Western Union, while individuals with bitcoin retained the ability to send money globally. Miller contends that bitcoin can serve as effective insurance, citing its resilience during the initial stages of the pandemic when the Federal Reserve intervened and bailed out mortgage rates. He observed that bitcoin faced no issues during that period and experienced a significant increase in value as its owners recognized the impending inflation. In his view, it functions as an insurance policy (*kriptoworld*, 2022).

There are also differing views among researchers on the risk-weighted returns of investing in bitcoin. *Qin et al.* (2022) analyzed the impact of Bitcoin on stock portfolio's risk and return with Markowitz's investment theory and Monte Carlo simulation to find the optimal investment portfolio. Their results show that the return performance of the investment portfolio with Bitcoin is better than that of the traditional investment portfolio. *Henriques & Sadorsky* (2018) investigated the implications of replacing gold in an investment portfolio with bitcoin ("digital gold"). Their approach is to use several different multivariate GARCH models (dynamic conditional correlation (DCC), asymmetric DCC (ADCC), generalized orthogonal GARCH (GO-GARCH)) to estimate minimum variance equity portfolios. They find that it is possible for an investor to substitute bitcoin for gold in an investment portfolio and achieve a higher risk-adjusted return. This conclusion was reached by *Gangwal* (2017) too when analyzing the effects of adding Bitcoin to a portfolio (stocks, bonds, Baltic index, MXEF, gold, real estate and crude oil) from 2<sup>nd</sup> of July, 2010 to 2<sup>nd</sup> of August, 2016. He concludes that adding Bitcoin to a portfolio, over the course of the considered period, always yielded a higher Sharpe ratio. This means that Bitcoin's returns offset its high volatility. However, there has been significant volatility in the price of Bitcoin in 2016-2021 years and our research fills a gap in the relationship between Bitcoin returns and risk in the post-2016 period.

## **MATERIALS AND METHODS**

Given the limited extent to which bitcoin can fulfill the functions of money, the subsequent chapter aims to derive conclusions about its potential as an investment through analysis. When evaluating an investment, solely examining the return on investment is inadequate as it fails to account for the associated risks. Various types of risks exist, including default risk, counterparty risk, and notably, exchange rate risk, which remains a constant concern for investors. Therefore, it is essential to consider this factor to obtain a clearer assessment of an investment. Given its substantial volatility, this study utilizes the Sharpe ratio and Sortino ratio to evaluate the performance of bitcoin as an investment vehicle.

The Sharpe ratio and Sortino ratio utilize stock price data from Yahoo Finance spanning from 01.01.2016 to 31.12.2021. We chose this period because crypto-market was much less developed before 2016, but post-2020 shocks could distort the results. The short-term stock market crash in 2020 significantly increased the global stock market risk (*Vancsura & Bareith*, 2023).

To calculate these ratios, daily returns were computed by taking the difference between daily closing prices. As a risk measure, the standard deviation of returns

was chosen, derived from the time series of daily returns for each year by dividing the average of daily returns by the standard deviation of daily returns. Furthermore, the returns were adjusted by the risk-free rate of return, achieved by subtracting the daily 0.0136% RWA+ return from the daily return. For the examined period, the risk-free rate of return was set at 4.95% per annum.

The Sharpe ratio assesses the risk associated with the achieved return. Its formula incorporates the risk-free rate of return, representing the excess return earned by the investment per unit of risk taken (*Sharpe, 1994*).

*Calculation:*

Sharpe ratio = (annualized return on investment asset - annualized risk-free rate of return) / standard deviation of return on investment asset

Example of use: Consider two investments, „A” and „B”. We know that investment A has a return of 11% and investment B has a return of 16%. This obviously makes investment B the more attractive investment, but if we add that investment A had a spread of 3%, while investment B had a spread of 6% and the risk-free annual return was 2%, then if we plug the data into the Sharpe ratio formula, we get the following result.

- The Sharpe ratio of investment A is  $(11-2)/3= 3$ , so for 1% extra risk, we can get 3% extra return.
- Sharpe ratio of investment B:  $(16-2)/6= 2.33$

This makes investment A the better choice.

An inherent limitation of this indicator is its assumption of a normal distribution of returns, penalizing positive-skewed price movements. To address this, investment funds such as hedge funds employing volatile exchange rates utilize the Sortino ratio, which exclusively considers the standard deviation of negative price movements.

The formula for the Sortino ratio is akin to the Sharpe ratio, incorporating the standard deviation attributable to price declines of the investment asset (*Sortino & Meer, 1991*).

*Calculation:*

Sortino ratio = (annualized return on investment asset - annualized return available without risk) / standard deviation of price decline of the investment asset

Example of use: „A” mutual fund return 16%, risk free return 3%, negative return, standard deviation 12%.

„Mutual fund B return 13%, risk free return 3%, variance 7%.

- The Sortino rate of investment A:  $(16-3)/12= 1.083$ , so 1% negative downside is associated with a return of 1.083%.
- Sortino rate for investment B:  $(13-3)/7= 1.428$ , i.e. 1% negative return associated with a return of 1.428% (*Sortino & Meer, 1991*)

Although past returns are not an accurate predictor of future expected returns, they provide investors with a point of reference for fund performance. The indicators mentioned above allow investors to consider the risks they are taking and provide an overview of the differences between portfolio managers.

## RESULTS AND DISCUSSION

Bitcoin accounts for almost half of the market capitalisation of cryptocurrencies, which means that changes in its exchange rate have a significant impact on the exchange rate of other cryptocurrencies. To illustrate this, the correlation between bitcoin (btc) and three major cryptocurrencies (Ethereum = eth, ripple = xrp, litecoin = ltc) is shown in *Table 1*. As ethereum and ripple are newer cryptocurrencies, the reference period for the calculation of the correlation is 09.11.2017 to 31.12.2021.

**Table 1: Correlation between bitcoin, ethereum, ripple and litecoin exchange rate movements from 09.11.2017 to 31.12.2017**

	btc	eth	xrp	ltc
btc	1			
eth	0.919925	1		
xrp	0.556861	0.661923	1	
ltc	0.735614	0.723008	0.811749	1

Source: Based on Yahoo Finance data

The values show that the currencies under study show a positive, strong correlation with the price of bitcoin, especially in the case of ethereum, with a correlation value of 0.92, which indicates a close relationship in the fluctuations of the two cryptocurrencies' exchange rates.

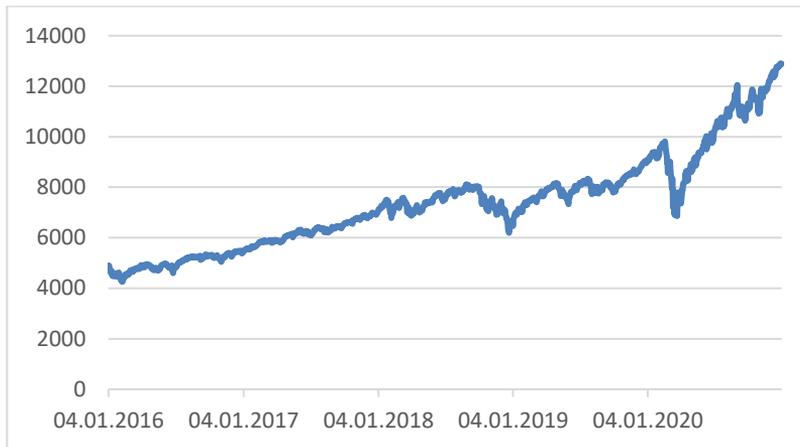
This dominant role makes it worth analysing the bitcoin exchange rate if you are interested in the cryptocurrency market over a given period.

In addition, the correlation with the stock market was examined and compared with the NASDAQ price, the evolution of which is illustrated in *Figure 1*.

The result was surprising, as the expected result was that bitcoin is a good alternative for portfolio diversification, but the correlation result of 0.62 shows the opposite, as the result shows that it falls along with the big tech companies' stocks due to a medium-strong correlation. So overall, bitcoin is becoming less and less of an alternative to stocks.

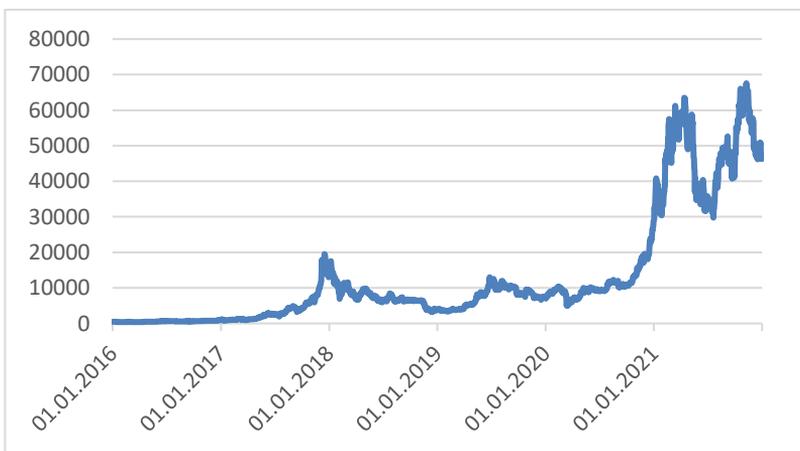
*Figure 2* shows a simple line graph of the price movements over the reference period. An upward trend can be seen, with the daily value of bitcoin rising from \$430 to \$46 300 over the period, i.e. roughly 107 times. It should be borne in mind, however, that this extraordinary increase has been accompanied by extremely high volatility, i.e. extremely high risk. The graph shows that the growth in the value of bitcoin really took off at the end of 2020, when it went from USD 11 000 to USD 65 000. After that, the exchange rate started to fall sharply, but after hitting a low of around USD 30 000, the exchange rate started to rise again, reaching a value of over USD 65 000 again. The rise in 2020 is different from that of 2017, as in 2020 large corporate players (Grayscale, Tesla) have already increased their bitcoin buying base.

**Figure 1: NASDAQ share price evolution (USD)**



Source: Based on Yahoo Finance data

**Figure 2: Bitcoin exchange rate evolution (USD)**



Source: Based on Yahoo Finance data

The period from 31.08.2021 to 31.08.2022 is a good counterpoint to the growth period, as this is when the market is experiencing a big decline. From a value of almost \$70 000, it has fallen to \$20 000, which is shown in *Figure 3*. There are several reasons for this downward trend.

Firstly, the riots and protests that broke out in Kazakhstan did not help the bitcoin price. After China banned mining, many people settled here due to cheap electricity. However, the protests have restricted internet access, making the miners' activities unfeasible. This in turn is causing the bitcoin's exchange rate to fall.

On the other hand, the interest rate hike announced by the Federal Reserve has also had a negative impact on the exchange rate due to rising inflation. As bitcoin is

considered a risky form of investment, the interest rate hike has had a significant negative impact.

It was also impacted by the emergence of the omicron variant of the coronavirus, which introduced a significant uncertainty. There was no way of knowing what measures would be taken or what the impact would be on the global economy as a whole. In such situations, investor confidence is also shaken.

**Figure 3: Bitcoin trend and exchange rate development (US dollar)**



Source: Based on Yahoo Finance data

Its investment assessment may be based on a combined analysis of its profitability and risk profile. For this purpose, the study uses the exchange rate data from Yahoo Finance for the period 01.01.2016 to 31.12.2022.

Risk-free interest rates are provided by risk-free return investments. Examples include government bonds and treasury bills. A nominal value that protects the investor against expected inflation, thus providing a positive real return to the investor.

Although other risk-free investments with dynamically changing daily returns may be a realistic choice, we believe that the daily return of the government bonds MÁP+, which is available to Hungarian retail investors and is very popular during the period under review, is the best choice as a risk-free alternative.

The returns were then adjusted by the risk-free rate of return, whereby the daily return was adjusted by 0.0136% MÁP+ government bonds return per day. This was set at 4.95% per annum as the risk-free rate of return over the period under review. In this case, if we compare only the risk premium to the risk (standard deviation, since the standard deviation/risk of the government bond yield is 0) for the return, we have a Sharpe ratio of bitcoin of only 0.95, as shown in *Table 2*. So although there have been high returns over the period 2016-2021, it has a value below 1 based on the risk due to yield volatility, which means that it is not a good investment.

First, a daily return is defined as the difference between the daily closing prices. As a risk measure, the standard deviation of returns is chosen, which is obtained by using the time series of daily returns for each year by dividing the average of daily

returns by the standard deviation of daily returns. The Sharpe ratio is 1.02 for the entire period under consideration, which means that for a unit (one percent) of risk, we get almost exactly one unit of return premium.

**Table 2: Sharpe ratio of Bitcoin 2016-2021**

	Bitcoin daily average return	Bitcoin return standard deviation	Alternative yield 4,95%	Sortino	Sharpe adjusted for alternative yield
<b>Total</b>	0.0021	0.0399	0.000136	<b>1.02</b>	<b>0.95</b>
<b>2016</b>	0.0022	0.0253	0.000136	1.65	1.55
<b>2017</b>	0.0074	0.0493	0.000136	2.85	2.80
<b>2018</b>	-0.0036	0.0429	0.000136	-1.62	-1.68
<b>2019</b>	0.0018	0.0353	0.000136	0.97	0.89
<b>2020</b>	0.0038	0.0401	0.000136	1.82	1.75
<b>2021</b>	0.0013	0.0420	0.000136	0.58	0.52

Source: based on Yahoo Finance data

A value between 0 and 1: Indicates that, compared to a risk-free asset fund, the hedge fund under study can only generate less than one unit of return for every unit of risk taken.

A value between 1 and 2: The risk/return ratio is reversed, i.e. higher risk is associated with higher return.

Between 2 and 3: These are asset funds that promise at least two or more times the return for each unit of risk (*Sharpe, 1994*).

The Sortino indicator is more suitable for testing assets that have high volatility. As can be seen in *Table 3*, it achieves better values than the Sharpe ratio presented above. The reason for this is that the Sortino ratio does not take into account the variance due to positive volatility. In this case, the result is that since we have not defined volatility as a risk, but only exchange rate movements, it is worth buying bitcoins, as the Sortino rate will be high.

**Table 3: Bitcoin Sortino rate 2016-2021**

	Bitcoin daily average return	Bitcoin return standard deviation*	Alternative yield 4,95%	Sortino	Sortino adjusted for alternative yield
<b>Total</b>	0.0021	0.0326	0.000136	<b>1.25</b>	<b>1.168</b>
<b>2016</b>	0.0022	0.0224	0.000136	1.86	1.743
<b>2017</b>	0.0074	0.0365	0.000136	3.85	3.780
<b>2018</b>	-0.0036	0.0339	0.000136	-2.05	-2.129
<b>2019</b>	0.0018	0.0256	0.000136	1.34	1.234
<b>2020</b>	0.0038	0.0407	0.000136	1.79	1.724
<b>2021</b>	0.0013	0.0287	0.000136	0.85	0.763

\* only due to negative volatility

Source: Based on Yahoo Finance data

The results show that it was mostly worth investing in bitcoin in 2017, with those who invested in this year making big gains. Conversely, the same cannot be said for those who entered in 2018, as we can see that both rates were negative. The year 2021 was not the year of bitcoin either, as both the Sharpe and Sortino ratios were below 1, which makes it a bad investment, and the Sharpe ratio also shows that the same can be said for 2019, although it is only slightly below 0.97. In 2016, 2019 and 2020, it scored between 1 and 2, meaning that higher risk was associated with higher returns.

It can also be seen from the results that bitcoin is a very hectic investment, but those who were risk takers and got in at the right time profited from it, as opposed to those who chose the wrong time to buy.

## **CONCLUSIONS**

Analyzing and researching the risk associated with cryptocurrencies is of paramount importance for several reasons. For individuals and institutional investors, cryptocurrencies represent an increasingly attractive investment option. Understanding the risks allows investors to make informed decisions about allocating their capital. Without adequate analysis, investors may be unaware of the potential downsides and might face unexpected financial losses. By identifying and assessing risks, investors can implement strategies to mitigate them. Failing to research and understand the legal and regulatory risks can result in non-compliance, legal issues, and potential financial penalties. Staying informed about regulatory changes is crucial for cryptocurrency businesses and users. Cryptocurrency markets are notoriously volatile. In-depth analysis can help investors anticipate and respond to market fluctuations. This knowledge can be especially valuable when making trading decisions, as timing can significantly impact profitability.

As the world becomes more uncertain, the more important it becomes to have a stable store of value, traditionally gold. Many people refer to bitcoin as digital gold. However, it is difficult to verify this claim on the basis of the period under review (2016-2021). Although it has risen significantly, it has a very high volatility, as the results show. It is therefore a significant risk to take if you choose this investment alternative. It can be seen that there have been some outlier years, such as 2017, when a very good return was achieved, but the opposite happened in the following year, when both the Sharpe ratio and the Sortino ratio turned negative.

It also moved with the price of risky tech stocks, as shown by the NASDAQ correlation of 0.62. This is significant because when risk aversion appears in the market, the share price weakens, while gold rises on historical data. And over the past year, we can see that the price of bitcoin has fallen significantly during the period of crisis.

It is advisable to gather information from as many sources as possible to make the right decision. All in all, the future of the cryptocurrency market is full of uncertainties. The year 2021 was not the year of bitcoin either, as both the Sharpe and Sortino ratios were below 1, which makes it a bad investment, and the Sharpe ratio also shows that the same can be said for 2019, although it is only slightly

below 0.97. In 2016, 2019 and 2020, it scored between 1 and 2, meaning that higher risk was associated with higher returns.

It can also be seen from the results that bitcoin is a very hectic investment, but those who are risk takers and got in at the right time could profit from it, as opposed to those who chose the wrong time to buy. Based on our results, there were years between 2016-2021 when bitcoin was a good investment, but in most cases its returns were associated with excessive volatility and risk. For this reason, it is not recommended for risk-averse rational investors.

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