

# *Exchange Rate Developments of Cryptocurrencies Based on Event Study Analysis*

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## SUMMARY

As the cryptocurrency market dynamically evolves, important financial and economic issues arise. The main focus of the present research is on the price of cryptocurrencies. Following the exploration of the literature base, special emphasis was put on the comparison between the crypto market and markets for different asset classes (gold, stocks, foreign currency) and on the identification of connection points. Next, the article focuses on the period after 2020, and applies the event study methodology in order to establish, how the two cryptocurrencies with the highest market capitalization (Bitcoin and Ethereum) reacted to selected events. These events mainly encompassed hacker attacks aimed at the systems that form the basis of the operation of cryptocurrencies, and also certain steps regarding their regulation and application. Overall, it was established that hacker attacks did not have a significant effect on the exchange rates of the two examined cryptocurrencies. Effects of regulatory action on prices are mixed, however even significant effects can be regarded as short-lived.

KEYWORDS: cryptocurrencies, Bitcoin, Ethereum, event study

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The period after the 2018 crisis was accompanied by the explosive growth of the cryptocurrency market. The market capitalization of the cryptocurrencies reached its peak in November 2021 exceeding 3 trillion dollars; in 2022, more than 13.000 different types of digital money were registered. So far cryptocurrencies have not brought along the revolution of the payment-financial system; they primarily function as a rather high-risk investment instrument. In addition, the increasing level of investor exposure may also carry real economic consequences due to the considerable fluctuation of the savings' value.

Because of the financial and real economic effects, cryptocurrencies form the subject matter of inspections more often within the framework of economic analyses. Their rapidly changing market, by all means, gives cause to the inspection of their exchange rate, as well as the identification of the respective speculative and fundamental factors. The analysis of the crypto money requires a detailed exploration of its relationship with the market of other assets, including the stock markets, the foreign currency markets, and the exchange rate of precious metals or other cryptocurrencies. In addition to the above, the external phenomena concerning the peculiarities of cryptocurrencies such as hacker attacks, regulation related reports, technological innovations, etc. are also important.

This study gives details of the type of events which affect the exchange rate of cryptocurrencies. In addition to the exploration of the theoretical relations, the study attempts to provide more information also within the framework of empirical relations. The event study analysis outlines whether certain events (cyber-attacks in connection with cryptocurrencies, regulatory measures) significantly influence the exchange rate of digital currencies. The analysis primarily focuses on the examination of Bitcoin's ('BTC') exchange rate after 2020.

The events highlighted in the article – relating to regulation and use – also concern Bitcoin. The research also explores how the selected events impact Ethereum.

## FACTORS INFLUENCING THE EXCHANGE RATE OF THE CRYPTOCURRENCIES

The future and value of cryptocurrencies are highly influenced by their usefulness in terms of economics, that is which functions they are able to fulfil and to what problems they provide a solution. It helps in the evaluation if we compare the cryptocurrencies to fiat money with the coverage of the central bank based on their functions and other characteristics. Money issued by central banks are able to perform five main functions as per the classic definition:

- they function as medium of exchange;
- they can be used as unit of account;
- they are present as means of payment;
- they fulfil a function as a store of value; and
- they may be able to perform the role of world money.

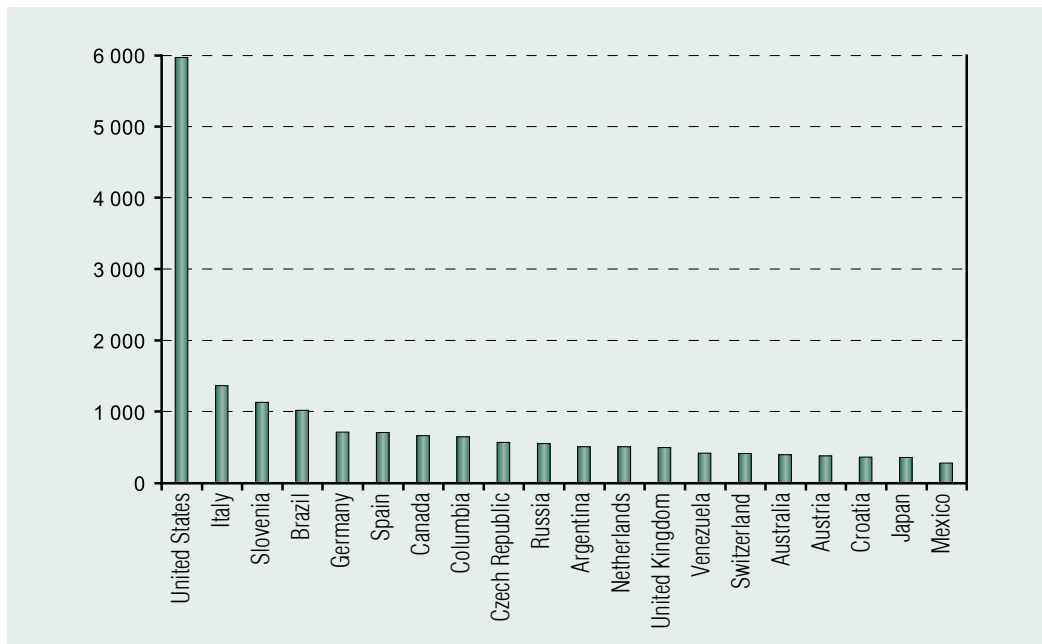
As regards the 'means of exchange' function, it is shown that at the beginning of the 2020s, the number of enterprises, which accept various cryptocurrencies to execute their transactions is high.

It is clear from *Figure 1* that the number of enterprises in the USA that either have cryptocurrency ATM or provide the possibility to pay with cryptocurrencies is nearly 6,000. It largely exceeds the data of other countries, however, it may be highlighted that the number of the respective enterprises for the 146 countries in the world exceeds 27,000, while the number of crypto users exceeded 300 million globally by 2022.

The current trends and the attempts at accepting cryptocurrencies as means of

Figure 1

### THE NUMBER OF ENTERPRISES, WHICH HAVE CRYPTOCURRENCY ATM OR PROVIDE THE POSSIBILITY TO PAY WITH CRYPTOCURRENCIES



Note: Data as of 9 March, 2021, based on the data of the 20 countries with the highest number of enterprises

Source: Statista

exchange primarily strengthen the dominance of Bitcoin (Lisa, 2021). Similarly, Bitcoin has become the official means of payment in a sovereign state: first in El Salvador, in 2021, then in the Central African Republic, in 2022. By examining Bitcoin's role as a store of value, *Baur-Dimpfl* (2021) emphasize that since the supply of Bitcoin is limited and the mineable quantity is no more than 21 million pieces, it may be able perform this function despite its high volatility. Due to its limited nature, supply never follows demand, thus the continuous inflation characteristic of fiat money is less common. Nevertheless, the boost of cryptocurrencies happened in a primarily low-inflation environment with risk-taking investors. For the time being, in a real economy environment dominated by growing

recession fears, there is a limited experience to determine the function of cryptocurrencies as a store of value. *Baur-Dimpfl* (2021), however draw attention to the fact that this extreme volatility highly prevents Bitcoin from being regarded as unit of account. Notwithstanding the above, it is important to note that if the cryptocurrency will be much more widely accepted as means of payment and it will have a larger investor and institutional background, the increased confidence may decrease the volatility extensively.

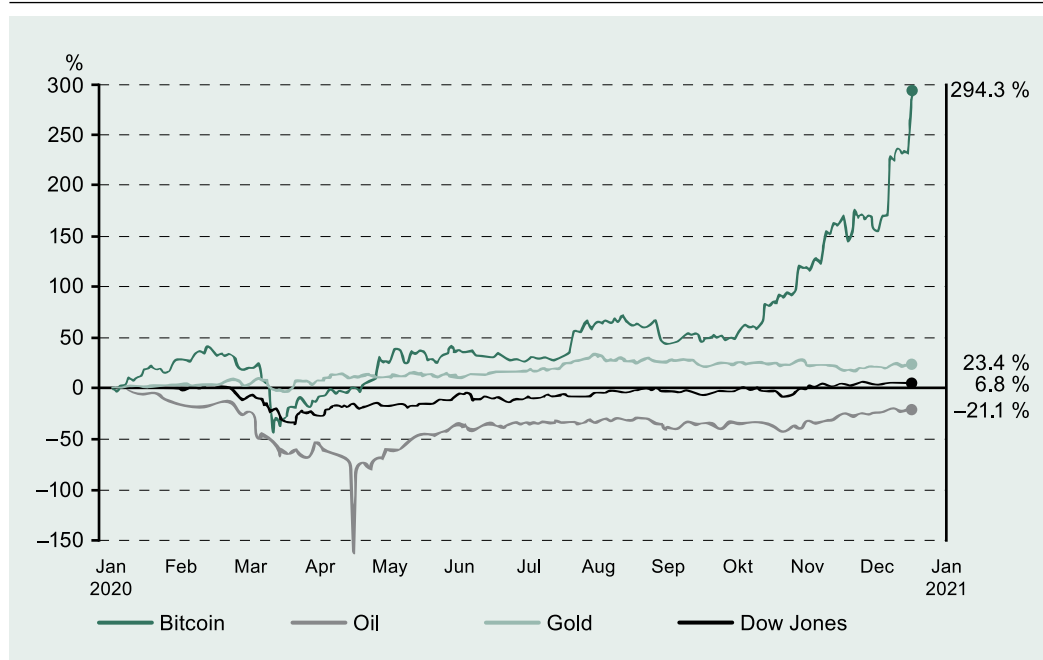
In order to identify the fluctuations of exchange rates, it is essential to examine how the crypto market relates to conventional markets such as gold, certain stock market indices or the movement of foreign currency markets.

Gold may be considered a classic store of value and safe haven, the functions of which have a long history. Among cryptocurrencies, Bitcoin, which currently has the largest market capitalization, is often perceived as the ‘digital gold’ referring to the fact that the characteristics of the digital currency make it perform similar functions as gold. Based on the May 2021 report of *J. P. Morgan*, the investors are inclined to buy Bitcoin at the time of Covid-19 instead of gold as a defense against inflation. However, the analytical research of *Klein et al.* (2018) regarding the period between 2011 and 2017, has not yet confirmed the above connection. Based on their BEKK–GARCH model, Bitcoin is not able to serve as an appropriate coverage as opposed to gold and thereby it cannot

mitigate the risk of capital investments. However, it has been found that the yield of Bitcoin reacts asymmetrically to the various market shocks in the same direction as precious metals. If Bitcoin’s price starts to increase, it will increase volatility. The relationship between cryptocurrencies and gold was examined by *Gonzalez et al.* (2021) with the non-linear autoregressive distributed lag model during the first wave of the Covid-19 pandemic. They found that the yield of cryptocurrencies they examined<sup>1</sup> positively and significantly correlated with that of gold in terms of statistics. Based on their results, they conclude that in the period of economic turbulences, the relationship between cryptocurrencies and gold is getting stronger as regards yields. *Figure 2* examines

Figure 2

**THE PRICE DEVELOPMENT OF BITCOIN, OIL, GOLD AND THE DOW JONES INDUSTRIAL AVERAGE DURING 2020, COMPARED TO THE BEGINNING OF THE YEAR**



Source: capital.com, Pankratyeva (2021)

2020 including the mentioned period and shows that Bitcoin started to rise similarly to gold after its fall in March. Although the increase in Bitcoin's exchange rate was much more intense during the year, it was also accompanied by higher volatility. However, it is also striking that the Dow Jones Industrial Average including the largest enterprises of the United States of America took a slow development path after its loss in value in March, while the oil price ended the year negatively. It can be seen that Bitcoin's price significantly increased in 2020, but as *Lee–Daniel* (2021) also states: 'Bitcoin has not yet shaken the status of gold'. It must also be emphasised that it may be a concern related to the future of Bitcoin that even though its supply is limited the number of cryptocurrencies can be indefinite, which may be a disadvantage as opposed to gold.

As regards the connecting points between stock and crypto markets, the research of *Jiang et al.* (2021) has found (focusing on the Covid–19 pandemic) that cryptocurrencies are not able to perform *hedge* or *safe haven* functions. They may have a role in portfolio diversification since the yield of crypto money and the stock market indices positively and significantly move together. Therefore, cryptocurrencies are less suitable for mitigating risk. However, by examining the coverage capability of Bitcoin and Ethereum against the inflationary expectations, *Conlon et al.* (2021) experienced that the two types of crypto money could play the coverage role in the first phase of the unfolding crisis relating to Covid–19. Their time series analysis, however, shows that the above links can hardly be confirmed in the long run. *Uzonwanne* (2021) examined the spillover effects between the stock markets and cryptocurrencies in the field of yields and volatility. The short-term performance of the S&P 500 index had a positive and significant effect on Bitcoin's price, while in the case of

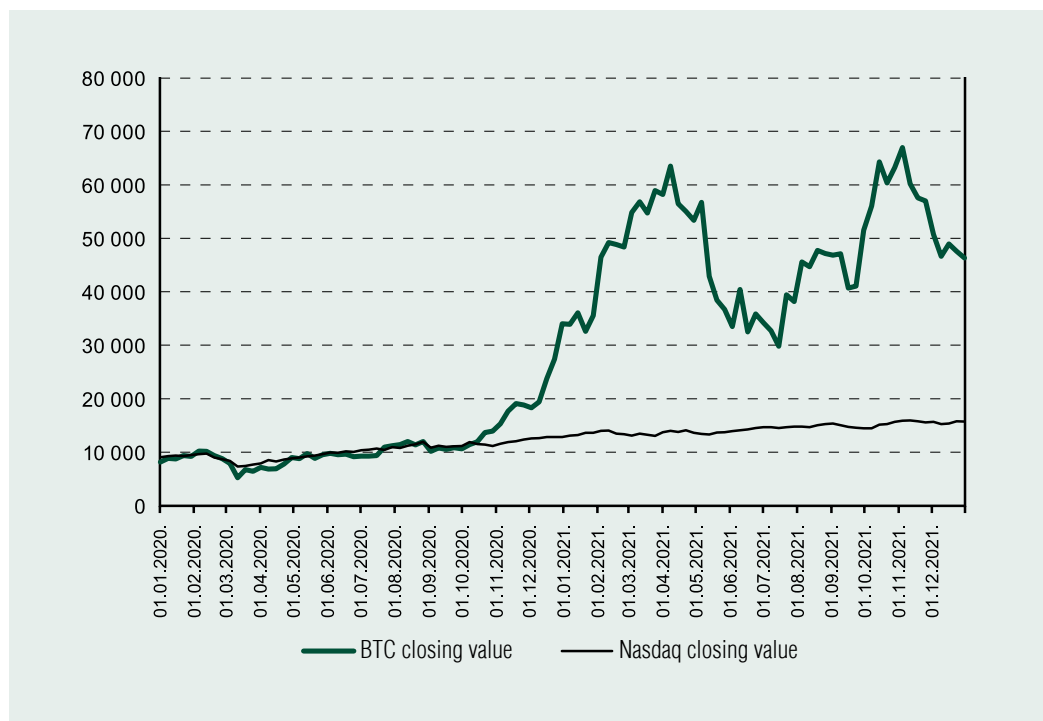
Nikkei 225 stock market index, two-way, negative, spilt effects can be observed in the long term.

*Figure 3* shows Bitcoin's price expressed in USD in 2020 and 2021, as well as the performance of the NASDAQ stock market index including the large, American technological firms. It can be seen that while after the decrease during the first wave of Covid–19 in 2020, Bitcoin moved on a slow path similar to the NASDAQ index, in 2021 the exchange rate of the cryptocurrency started to increase rapidly. As regards the weekly exchange rates, a much more significant fluctuation can be observed as compared to the previous period and the NASDAQ index. It does not mean, however, that there is no connection between the crypto market and the stock markets. In their analysis, *Hajric and Graffeo* (2021) state that the stock markets and the crypto market can move in tandem, however, even the relatively safe Bitcoin cannot guarantee the normal safety of the financial markets.

As regards the connections between the *crypto market* and the *foreign currency market*, the research of *Mokni and Ajni* (2021) studied the link between USD and the five leading cryptocurrencies (Bitcoin, Ethereum, Litecoin, Ripple and Bitcoin cash) with Granger's causality test. In their research, they have shown that before Covid–19, when the cryptocurrencies were in the bear market, then USD was the Granger-cause<sup>2</sup> of the cryptocurrencies, whereas during the pandemic, this changed, and the market of cryptocurrencies became the Granger-cause of the USD exchange rate.

*Aslanidis et al.* (2021) analyze the link between the various markets of crypto money. According to their findings, only 20% of the shocks affecting certain cryptocurrencies do not have a spilling effect on other cryptocurrencies. It can be observed,

### THE DEVELOPMENT OF BTC-USD AND THE NASDAQ STOCK MARKET INDEX (2020–2021) WEEKLY CLOSING VALUES



Source: own edit based on data of yahoo.finance.com

therefore, that the yields and volatility of the various cryptocurrencies are getting more and more interconnected. However, the various cryptocurrencies cannot be regarded as homogeneous assets, since the research of *Mensi et al.* (2021) shows that while Bitcoin, Ethereum and Litecoin are considered net risk bearers, the other types of crypto money are considered net risk recipients. In addition, the spilling of risk is stronger in the short term than in the middle- or long-term.

By analyzing the dynamics of the cryptocurrency market, *Vidal-Tomás* (2021) state that the market changed during the years: while between 2017 and 2019, the exchange rates of the different cryptocurrencies moved on a highly similar path, from 2019,

the cryptocurrencies with higher turnover dominated due to the market change. According to the authors, this type of maturity process must be evaluated positively, since as a result, the formation of bubbles became more avoidable. *Bouri et al.* (2019) also study the presence of price-explosivity in the cryptocurrency market. According to their results, if there is a boom in the exchange rate of a cryptocurrency, then there is a higher chance that the exchange rate of other cryptocurrencies also changes similarly. They also show that this kind of effect is less significant in the case of Bitcoin, the boom in the exchange rate of smaller cryptocurrencies may affect the exchange rate of other cryptocurrencies. Important links can be observed regarding

the effects of events influencing the exchange rate of cryptocurrencies. By examining the effects of the 2017 Chinese regulation *Borri-Shaknov* (2020) found in their analysis that the actions of governments intending to regulate the crypto market may be accompanied by heterogeneous spillover effects: as the number of Bitcoin transactions significantly grew in the case of transactions with the Japanese Yen, the Korean Won and the American dollar, while there was no similar phenomenon regarding the Euro. In addition, the popularity of peer-to-peer transaction platforms grew among the Chinese investors, since they offered the possibility to trade without a higher audit body. The research of *Walther et al.* (2019) also confirms the above links, that is the uncertainty related to the Chinese regulatory politics can forecast the volatility present in the crypto market.

The research of *Cao-Yie* (2021) also examines the effects of regulations concerning the crypto market. In connection with the Chinese cryptocurrency ban in September 2021, their study includes how this action influenced the relationship between the crypto market and the Chinese financial system. Their main conclusions contain that the risk was transferred from the Chinese financial market to the cryptocurrency market because of the ban, and the long-term correlation became weaker in relation to gold and crypto money, while the long-term cross-correlation became stronger in relation to the crypto market and the USD exchange rate. By collecting positive and negative news and evaluating their effects with the event study method, *Yue et al.* (2021) found that news relating to the regulation had an asymmetrical effect on the liquidity of the crypto market. While the effect of positive news may be accompanied by increased liquidity even after twenty days, the effect of negative news decreasing liquidity is eliminated after four days.

## METHODOLOGY

In the following section, further conclusions are drawn with the help of event study analysis regarding the exchange rate movement of cryptocurrencies. The event study methodology can examine if certain events, announcements and news had a significant impact on the given instrument's price. The basis of the event study rests on the Efficient Market Hypothesis or EMH created by *Fama* (1970). Based on this theory, the exchange rates reflect all information, that is, the trade of stocks or other different instruments happens at their real market value. So the asset prices reflect all publicly available information, as a result of which it is not possible to gain abnormal yield (surplus yield) with the fundamental or technical analysis.

Event study dates back to a long time. The first study was created by *James-Dolley* (1933) in which they examined what kind of exchange rate effects share splits have. The methodology was based on the tracking of nominal exchange rate changes at the date of splits. In the next nearly three decades, the *event study* models were becoming more and more sophisticated. The works of *Myers-Bakay* (1948), *Barker* (1956, 1957, 1958) or *Ashley* (1962) are outstanding in this area. It is one of the developments that the models now can filter the effects of the general stock exchange rate changes, and separate certain disturbing events from each other. The basis of the models in the 1960s is identical with the methodology of models used today. The work of *Fama et al.* (1969) is considered an important milestone (*MacKinlay*, 1997).

*Fama et al.* (1969) applied the event study methodology to examine the stock price changes after the announcement of certain events, such as the change of various accounting rules, announcements regarding revenue, the change of regulations and money supply.

Afterwards, event study became the standard methodology for stock price reactions. The practical application of event study, therefore, makes the testing of the hypothesis possible, according to which the markets effectively integrate information.

During the event study analyses, the first step is to determine the event to be examined and to identify the period – during which the asset prices may be concerned as regards the event’s effects – or to determine the event window. The event windows may be merely the date of the announcement, although in certain cases, it is useful to apply a longer event window. So, it is reasonable to integrate the days after the event announcement in the model, however, it may occur that the days before the announcement also form part of the examinations. It may be justified if the market obtains information before the actual announcement. These may include, for example, the data regarding the enterprise’s revenues. Therefore, it may be important to examine if the abnormal yield was present before the event (any internal information was present to which the market players could adjust their decisions), or if the Efficient Market Hypothesis was damaged after the occurrence, announcement of the event. Within the framework of the event study analysis, it is necessary to differentiate the estimation period from the subsequent observation period. The observation period includes the given event, the effect of which we intend to examine. The aim is to determine whether an abnormal yield was present after the event.

Calculations made during the estimation period provide the basis of the calculation of abnormal yields, which – according to *Obi* (2007) – has three main methods.

The mean-adjusted returns model or constant return model, the point of which is that the average yield based on the data of the

estimation period ( $\bar{R}$ ) is subtracted from the given daily yield ( $R_t$ ):

$$AR_t = R_t - \bar{R} \tag{1}$$

The essence of the market adjusted model is that the given daily market yield ( $R_{Mt}$ ) is subtracted from the given daily yield ( $R_t$ ):

$$AR_t = R_t - \bar{R}_{Mt} \tag{2}$$

The third type of model is the risk-adjusted model:

$$AR_t = R_t - (\alpha + \beta \times R_{Mt}), \tag{3}$$

where  $\alpha$  is the constant (intercept),  $\beta$  is the incline. In addition,  $\alpha$  and  $\beta$  are determined on the basis of the regression calculations based on the stock and market indices.

If the difference received based on the applied calculation method is significant, it can be assumed that the Efficient Market Hypothesis has been damaged. In other words, the examined event has a significant effect on the asset price.

## Data

Bitcoin and Ethereum, the two cryptocurrencies with the largest market capitalization provide the basis of our study. The examination period covers the period after 2020. The data come from the database of Investing and S&P Global. The length of the estimation period is 40 days within the framework of the present analysis. The relatively short interval is because the exchange rate of cryptocurrencies shows high volatility, and significant moves can be observed even in short periods. However, the average to be calculated in the case of the Constant Mean Return Model smooths these



larger swings which would interfere with the analysis accuracy.

We differentiated two main groups of the events to be examined during the event study analysis: events relating to hacker attacks, and events pertaining to the regulation and use of cryptocurrencies. The reason for this is that safety and the attackable nature are key aspects in the respect of cryptocurrencies. If the network and technology behind cryptocurrencies is unable to resist the various hacker attacks, the trust of users and investors may significantly decrease. Prospects deteriorate, which also have an adverse effect on the exchange rate. We selected the five largest hacker attacks concerning 2020 from the events being the subject of the examinations based on the collection of *IDEX* (2020). In addition, we chose certain hacker attacks in 2021 based on the data of SlowMist Hacked with special respect to the 50+1% attacks and the attacks concerning blockchain.

Crypto money, which was created for decentralization purposes and to become independent from the conventional financial system, increasingly raise the question of regulation. Due to the decentralized nature of cryptocurrencies, the transactions can be checked in a more difficult way, which may give rise to the stronger development of the underground economy and money laundering. *Magzinov et al.* (2019) call attention to the fact that in order to discourage the crime-financing potential of cryptocurrencies, it is important to create a regulatory environment for the states, which legally defines the status of the crypto money and specifies their limitations of use. As *Rehman et al.* (2020) emphasise, the lack of oversight may also undermine the trust in cryptocurrencies. According to their research, technology has to improve in many fields cryptocurrencies to become more widespread. The major problems they examined include the crypto market's lack

of transparency, the weaknesses of safety guarantees as well as the lack of a framework to be created by the regulatory bodies. According to some, it could be a solution to the trust issues around cryptocurrencies if the central banks as issuers were also present in the crypto markets. According to *Bech and Garatt* (2017), the advantage of this would be that the institutional guarantees provided by central banks, as well as the anonymity promised by the crypto money, would unite. However, the technical criteria of this solution are missing, and the central banks must consider how these actions may potentially influence the monetary policy. The conventional players of the crypto market must also develop in the field of safety, as highlighted by *Bucko et al.* (2015). There are many ways to attack the network of the cryptocurrencies, such as attacks against 'crypto money-wallets' or the creation of malicious hubs. The different safety risks may drive the potential investors away from the crypto market, as *Chohan* (2022) also reports, while he calls attention to the fact the crypto sector would need wider, more robust accountability and more effective supervision to sweep away the doubts of investors.

China shows a radical case of regulations, where the state power decided to ban the trade and use of cryptocurrencies, and the development of the digital central bank money, the digital Yuan received more emphasis. Events aiming at the regulation and the expansion/limitation of Bitcoin use primarily relate to the announcements of Iran, China, El Salvador, and Elon Musk, the CEO of Tesla. The inclusion of the latter may be considered justified as the exchange rate of cryptocurrencies may be influenced by the social media platforms and the events happening there. The events being the subject of the analysis are summarized in *Table 1*.

In the research, we examine the effect of the designated events with all three models, which

Table 1

**EVENTS BEING THE SUBJECT OF THE EXAMINATIONS**

	Event	Date	Code
Events pertaining to hacker attacks	Altsbit – 6,9 BTC; 23,21 ETH, 3924082 ARRR; 414154 VRSC; 1066 KMD loss	5 February 2020	Hack_1
	Uniswap – 300,000 \$ and 1.1 million imBTC token loss	18 April 2020	Hack_2
	Coincheck – only the theft of data, not a digital instrument	31 May 2020	Hack_3
	Balancer – Ether loss amounting to 500,000 USD	28 June 2020	Hack_4
	Cashaa – 366 BTC loss	11 July 2020	Hack_5
	Firo was under a 51% attack (direct financial loss cannot be identified).	20 January 2021	Hack_6
	Verge (XVG) suffered a 51% attack.	15 February 2021	Hack_7
	BSV was under a 51% attack, and nearly 100 blocks were reorganized.	4 August 2021	Hack_8
	During the attack on Liquid Network, block signatures were suspended temporarily during an attack, but the funds of the users remained intact.	5 October 2021	Hack_9
Events relating to regulation/use	Tesla buys Bitcoin at a value of 1,500 million USD and announces that they propose to accept Bitcoin as means of payment.	8 February 2021	Sz_1
	Elon Musk announces that he will no longer accept Bitcoin due to its harmful environmental effect.	12 May 2021	Sz_2
	Iran banned the mining of cryptocurrencies for 4 months.	26 May 2021	Sz_3
	El Salvador announced that Bitcoin would become the official means of payment.	5 June 2021	Sz_4
	Elon Musk announces that Tesla accepts Bitcoin as means of payment again.	21 July 2021	Sz_5
	In El Salvador, Bitcoin becomes the official means of payment.	7 September 2021	Sz_6
	China announces that it bans the trade, mining and use of cryptocurrencies.	24 September 2021	Sz_7

Source: own edit

enables a type of robustness examination. The 2020 hacker attacks are the exception to this since all of them happened on weekends, and in the case of the market index, only week-day data are available. Since the consequences of the events are typically short-term, concentrate

on one day, the results would have shown significant distortion due to the limited data. We measure the market yield with the S&P Cryptocurrency Broad Digital Market (BDM) Index. The index monitors the performance of digital assets, which are registered in

open digital stock markets and comply with the specified minimum liquidity and market capitalization requirements.

### Results

Tables 2 and 3 summarize the abnormal yields calculated based on certain models and the associated levels of significance.

During the analyses, it could be found that the hacker attacks had not had a

significant effect on the exchange rate of the examined cryptocurrencies. One event was an exception, the attack against Altsbit on 5 February 2020. The attack supporting the trade of various DeFi or cryptocurrencies or against other platforms did not shake the trust of investors. This is explained, among others, by the fact that a part of the attacks did not target the blockchain and did not damage the operational mechanism of Bitcoin or other cryptocurrencies as they remained intact. The data in the table show

Table 2

#### EVENTS RELATING TO HACKER ATTACKS

Event		AR_BTC (%)	AR_ETH (%)
Hack_1	CRM	5.2**	7.9
Hack_2	CRM	0.7	9.9
Hack_3	CRM	-0.5	-4.9
Hack_4	CRM	-2.8	1.8
Hack_5	CRM	-0.2	-0.9
Hack_6	CRM	-3.4	0.4
	MAM	1.9	3.8
	RAR	-2.9	4.5
Hack_7	CRM	-2.8	-3.8
	MAM	0.6	5.2
	RAR	1.8	2.9
Hack_8	CRM	3.81	8.4
	MAM	-1.3	3.1
	RAR	4.1	3.9
Hack_9	CRM	4.91	4.2
	MAM	2.3	1.7
	RAR	1.9 *	2.5

Note: significance with \*\*\*1%, \*\*5%, \*10%. AR\_BTC and AR\_ETH indicate the abnormal yield of Bitcoin and Ethereum, while CRM refers to the average adjusted model, MAM to the market adjusted model, and RAR to the risk-adjusted model.

Source: own calculations

## EVENTS RELATING TO REGULATION/USE

Event		AR_BTC (%)	AR_ETH (%)
Sz_1	CRM	<b>14.8**</b>	-0.83
	MAM	<b>8.5***</b>	<b>-10.8*</b>
	RAR	<b>9.2***</b>	<b>-15.3***</b>
Sz_2	CRM	<b>-9.8**</b>	<b>-10.1*</b>
	MAM	<b>-10.2***</b>	5.8
	RAR	<b>-14.7***</b>	12.3
Sz_3	CRM	3.1	4.6
	MAM	-4.7	0.3
	RAR	-3.1	10.5
Sz_4	CRM	-3.4	-2.6
	MAM	-4.7	0.3
	RAR	-3.1	10.4
Sz_5	CRM	<b>6.9*</b>	<b>12.3***</b>
	MAM	1.1	4.9
	RAR	2.2	3.7
Sz_6	CRM	<b>-11.0***</b>	<b>-12.6***</b>
	MAM	0.9	-0.6
	RAR	0.2	0.2
Sz_7	CRM	-3.9	-6.9
	MAM	1.2	-1.3
	RAR	-1.2	-7.1

Note: significance with \*\*\*1%, \*\*5%, \*10%. AR\_BTC and AR\_ETH indicate the abnormal yield of Bitcoin and Ethereum, while CRM refers to the average adjusted model, MAM to the market adjusted model, and RAR to the risk-adjusted model.

Source: own calculations

the abnormal yields regarding the day of the event, but the expansion of the event window to several days did not lead to different results either. Typically, the exchange rate of cryptocurrencies may show significant fluctuations even in short term, thus the application of an event window including several days is not necessarily justified.

As regards events relating to the regulation and use of Bitcoin, there are statistically significant effects on the exchange rate changes. The announcement of Tesla and Elon Musk in February – according to which, they will expectedly accept Bitcoin as means of payment – had a significant impact on Bitcoin's price with even 5%. The same is true for his

announcement of 12 May 2021 in which he withdrew his previous announcement due to the high energy use of Bitcoin and its polluting effect and would not accept bitcoin as planned. The announcement of 21 July 2021, in which he proposed the acceptance of Bitcoin, had a significant effect on the BTC exchange rate at 10% level.

In addition, the announcement of China, according to which they completely ban the mining and use of cryptocurrencies in the country, was not proved to be significant as regards the exchange rates. So the trust of investors was not shaken by the country's action. China had already attempted to restrict cryptocurrencies earlier. In 2019, it banned the trade of cryptocurrencies, but it allowed online trade with foreign platforms. It is important to note, however, that the analysis did not cover the examination of intraday data, thus the in-day fall in prices and the fast correction were not quantified in the model.

The event of 21 September 2021, when El Salvador announced that it would use Bitcoin as legal tender also had a significant impact on the cryptocurrency's exchange rate. The negative effects relating to the introduction are supported by many problems. For example, only half of the population uses the Internet (Kemp, 2021), which makes the spread of the digital means of payment difficult. The government prepared an application serving as a digital wallet, but many technical issues arose (Renteria, 2021). It adds to the problem that based on a local university survey, 90 per cent of the population does not know exactly what Bitcoin is.

The effect on Ethereum is not significant in either case relating to Bitcoin regulation, thus the respective data is not discussed in detail herein. In other words, the transmission of shocks is realized in a fairly limited manner, at least in the short term. Furthermore, it can be concluded that in the case of one-day effects,

the exchange rate reaction of Bitcoin and Ethereum was often different in its direction, and the difference was significant as regards the magnitude of the exchange rate change. The expansion of the event windows, and the estimations regarding the days before and after the event, do not change the above conclusions either.

## CONCLUSIONS

The increasing spreading of cryptocurrencies raises important economic questions.

In our research, the main emphasis was on the development of cryptocurrencies' exchange rates. Following the exploration of the literature base, special emphasis was put on the comparison between the crypto market and markets for different asset classes (gold, stocks, foreign currency) and on the identification of connection points. Although there are strong indications that Bitcoin – similarly to gold – may perform the role of a store of value or safe haven, this characteristic cannot be justified unambiguously. As regards stock exchange rates, it must be emphasized that there is positive co-movement between cryptocurrencies and stock indices. They are capable of mitigating the risk to a limited extent only, they could be given a larger role in the diversification of risk. The connection points between certain cryptocurrencies and other foreign currencies can be considered weak, however, there is a strong correlation in the movement of the exchange rate of certain cryptocurrencies. The spilling effects, as well as the transfer and receipt of risk, are significant. Regulations concerning the crypto market, as well as the hacker attacks, are not negligible factors either. These two aspects also form the basis of the research's empirical part.

With the help of the event study analysis,

the article examined the reactions to some selected events after 2020. These included mainly the hacker attacks against systems ensuring the operation of cryptocurrencies, and certain measures relating to their regulation and application. The main focal points of the analyses were Bitcoin and Ethereum, the two cryptocurrencies with the largest market capitalization.

Generally, it can be concluded that the hacker attacks did not have a significant impact on the exchange rate of the two examined cryptocurrencies. The reason for this may be the fact that no damage was caused to the blockchain technology in either case. Moreover, in many cases, the attacks targeted other platforms; these primarily were theft attempts, therefore they did not affect the operational mechanism of cryptocurrencies either.

It must be emphasised that the measures of China and Iran targeting the ban of the use

and mining of cryptocurrencies did not have a considerable effect either.

Due to the social media activity of Elon Musk, Bitcoin's exchange rate moved significantly, based on which it may be concluded that the fundamentals prevail to a lesser extent in the cryptocurrency market. There was high volatility in the exchange rates, which may also indicate that in the case of cryptocurrencies, the rapidly changing investor mood can have a larger effect on the exchange rate than the more conventional financial markets.

In addition to the aspects discussed in the article, the role of technological innovations and social media is worth considering. Retail investors are present in a higher number in the market of cryptocurrencies (the role of the institutional investors is smaller), and this may also reveal relevant correlations in the economic approach. ■

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#### NOTES

<sup>1</sup> Tether is an exception to this statement which – being a stable coin – follows the movement of the USD exchange rate.

<sup>2</sup> If the inclusion of the  $x$  variant in the model does not significantly improve the forecast of  $y$ ,  $x$  is not the Granger-cause of  $y$  (Vincze, 2018).

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