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BITCOIN PRICE AS ONE OF BASIC CRYPTOCURRENCIES IN RELATION TO THE BASIC STOCK MARKET'S INDICATORS*

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Abstract. During 2020, factors such as the global pandemic, financial uncertainty and the US election saw an increase in the correlation between bitcoin and gold and the stock market. Both bitcoins and gold rose sharply during 2020, thanks to the relentless press of fiat money by governments and central banks that intend to keep their economies afloat as a result of the coronavirus pandemic. As digital gold, BTC appeals to the cashless Internet economy largely for its features, which include continuous price transparency and a lack of restrictions, disruptions or third-party oversight. The paper focuses on the analysis and identification of the relationship between the value of basic cryptocurrencies and gold price movements, as well as the research hypothesis that the value of the most known and used cryptocurrency bitcoin (BTC) increases with the rising price of gold - a special commodity that serves several functions of the world economy. This issue is currently gaining more and more attention also in context of risk management which is the identification, evaluation, and prioritization of risks followed by coordinated and economical application of resources to minimize, monitor, and control the probability or impact of unfortunate events or to maximize the realization of opportunities and mobile commerce in the aspect of the impact of modern technologies and mobile communication platforms on consumer behavior and consumer preferences. Innovatively, we have made our observations of the price of bitcoin in relation to price fluctuations in the gold markets in order to develop a predictive model for simulating the development of the price of bitcoin. The mathematical model was developed on the basis of statistical analysis of the observed data.

Keywords: Bitcoin; Bitcoin price; gold price; cryptocurrency; virtual money; financial risk; risk management; electronic and mobile commerce; modern technologies; consumer behavior; consumer preferences.

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JEL Classifications: D30, E30, F39, G20

1. Introduction

The global Cryptocurrencies (CC) market has been growing rapidly over the past few years. The paper deals with the research question whether there exist a relationship between the market value of basic cryptocurrencies and the value of basic stock market's indicators (gold price). Our study is aimed particularly to the one of four top cryptocurrencies - to Bitcoin (BTC) in relation to movements in gold prices.

In general European Central Bank (ECB) defines the virtual currency as a type of unregulated digital (or virtual) currency, that is emitted and usually controlled by developers and used and accepted by members of specific virtual community. According to material ECB19 today the virtual currencies from regulation point of view:

- do not pose any risk to a price stability, providing that money generation remains low,
- have tendency to be volatile, but this does not jeopardize the stability of financial sector due to its limited interconnectedness to real economy, low trading volumes and insufficient user acceptance,
- are not currently regulated or supervised by public authorities, even if they are exposed to credit, liquidity, operational and legal risk,
- can pose a problem for public authorities due to legal uncertainty that surrounds them and can be used by various fraudsters and those who use them to launder their proceeds of crime,
- may pose a reputational risk to central banks if they do not take action against them in a timely manner and prevent any damage that may be incurred by entities in dealing with them,
- fall under the responsibility of central banks due to their similarity to payment systems and lead to the need to investigate their development and to monitor and evaluate them on an ongoing basis.

The advantage of trading bitcoins is reduction of transaction costs to a minimum. Transactions can take place anytime, anywhere and do not require direct interaction between transaction participants. This means significant savings in terms of production, transportation and manipulation of physical money. Transactions are anonymous, accounts are not registered anywhere, and bitcoins are sent directly from one account to another.

On the other hand, one of the often mentioned negatives is the high volatility of the bitcoin exchange rate in relation to official currencies. There is no fixed exchange rate between bitcoins and common currencies. Although bitcoin, due to its decentralized nature, can withstand various interventions by governments, its legal status still remains an issue. The fact that bitcoin still exists in most countries in the so-called grey area (unregulated market), has a major impact on demand from both consumers and traders.

Another argument against bitcoins is that they are used for criminal purposes, such as terrorist financing, the promotion of human trafficking, money laundering or the trafficking of illicit substances of various kinds (Brezo and Bringas 2012). Attributing an increase in criminal activity only to bitcoins is pointless, however it is through unregulated and partly anonymous bitcoins trading that there is room for their abuse. It could be argued that money in forced circulation (e.g. euros or dollars) is also used for criminal purposes. However, potential criminals still have a hard time with the fact that they cannot simply make transfers from one account to another, as they would be easily detectable and law enforcement authorities would have no problem identifying and tracing them through bank transfers. The payment system is strictly regulated and entities are obliged, among other things, to

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report any suspicious transactions. In the case of bitcoins, it is really enough that they are transferred from one online account to another without it being possible to trace the originator and recipient of this transfer.

What is innovative is that we have performed our observations of Bitcoin price in relation to the price fluctuations from gold markets in order to develop predictive model for simulation bitcoin price trend. The mathematical model was developed based on the statistical analysis.

2. Theoretical background

Cryptocurrencies are the only type of currencies with the following three features: ensuring pseudo-anonymity, independence from central authority and double spending attack protection. As of 2018, Bitcoin is the most commonly known and used cryptocurrency. Bitcoin (BTC) is a consensual network that enables a new payment system and a complete digital currency. It uses its users and it uses peer-to-peer technology to enable instant electronic payments (Bartos 2015, Nakamoto 2008) based on mathematical proof and relies on cryptographic protocols. It is progressed by consensus network, namely open source software (Giungato et al. 2017, Nakamoto 2008). Bitcoin consists of the Bitcoin protocol, the block chain, distributed mining and transaction script (Antonopoulos 2014). According to his advocates, the ultimate goal is to serve as an alternative to traditional payment systems (Lo and Wang 2014).

On 31 October 2008 an individual or group of individuals operating under the pseudonym Satoshi Nakamoto published the Bitcoin Whitepaper and described it as a purely equivalent version of electronic cash that would allow online payments to be made directly from one side to the other without passing through a financial institution. For many, the true value of Bitcoin is not its currency function, but the technology behind it. Bitcoin is a complex system and its implementation involves a combination of cryptography, algorithms and controlled behavior (Badev and Chen 2014). Everything relies on software operations in the hard core of the system called blockchain (Pagliery 2014). It is a common public book on which the entire Bitcoin network as well as other decentralized cryptocurrencies rely.

The cryptocurrencies and related technologies can bring enormous value to the economic and financial spheres (Perera et al. 2020, Lee 2019, Nathan et al. 2019), which can significantly promote the outbreak of the Fourth Industrial Revolution. As the first decentralized cryptocurrency, Bitcoin is a virtual encrypted digital currency in peer-to-peer (P2P) form which has been invented by Satoshi Nakamoto (Nakamoto 2008). He followed up on an article from 1998 by Wei Dai, a graduate of the University of Washington, who presented the vision of creating a means of exchange that will not pass through the clearing systems of financial institutions and in which it will not be possible to intervene mainly by the government, central banks respectively. Bitcoin is not an absolute novelty, because in the recent past various other digital currencies have already operated, or more precisely they still operate nowadays such as DigiCash, GoldMoney, Pecunix, Web-Money. Bitcoin however is by far the most sophisticated digital currency yet. Unlike regular fiat money a Bitcoin has no physical form, it is not a legal tender, it is not issued by any government bank or organization (Murphy et al. 2015), its supply is not manipulated by a government or other central authority (Yermack 2013), and can be inflated at will (Kurihara and Fukushima 2017).

Each bitcoin created has an assignment to a specific key or address, making each bitcoin unique. A bitcoin transaction occurs when one bitcoin moves from one address to another. The public database records each bitcoin transaction or trade. The database is called a block chain. Hence, a block chain is like a book containing the ledger of all past transactions (Chiu and Koeppl 2017, Ivančík 2021). Every bitcoin exists inside the database, so no coins are held outside it. The supply of cryptocurrency depends on mining. Each individual bitcoin is added to the database through this mining process (Dwyer 2015, Prokopenko and Omelyanenko 2020). However, each cryptocurrency works in a different way, leading to different degrees of decentralization. In other words, some

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cryptocurrencies may be considered more decentralised than others, depending on the structure of the network and the way of distribution (O'Gorman 2018).

It is important to note that in the early days of the Bitcoin market, buyers were extremely confused about the use of it, and Bitcoin price (BP) was volatile (Carlos 1990, Okorie and Lin 2020, Javaria et al. 2020). There is an abundant literature supporting this conjecture. Dyhrberg (2016) suggests that Bitcoin is beneficial for risk-averse investors to maintain their returns if they face the expected negative shocks to the market. Gajardo et al. (2018) identify that Bitcoin has an interrelationship with commodities. Bouri and Gupta (2019) evidence that bitcoin is a hedge against uncertainty which partly caused by the market fluctuations. As high market fluctuations makes the public panic and the economy unstable, López-Cabarcos et al. (2019) indicate that investor sentiment has certain influences on BP and Bitcoin volatility. Symitsi and Chalvatzis (2019) reveal that there are significant diversification benefits from Bitcoin within traditional asset portfolios, especially in the portfolios of commodities (Guesmi 2019). Cryptocurrencies are used as financial instruments and especially Bitcoin is called alternative investment with diversification benefits (Gogo 2020, Briére et al. 2013).

The modern economy currently uses the so-called fiat money, which is similar to money covered by a particular commodity (e.g. gold during the so-called gold standard), but its concept is completely different in that it is not linked to another commodity (Mura and Buleca 2012, Orgonáš et al. 2020). Enforcement here takes the form of a legal norm by which a public authority establishes and implements a specific system of money and systematically regulates with its legal system the individual aspects of its circulation and protection, thus enshrining the currency as a legal form of money (Godany et al. 2021, Repnikova et al. 2019, Wulandari et al. 2019). The establishment of a currency is always a legal act and the currency is one of the attributes of state sovereignty (Prokopenko and Kornatowski 2018). The state uses the so-called monetary sovereignty, which according to the international principle lex monetae means that each state has the exclusive right to create its own currency (and dispose of it), which other states and their bodies must respect. Under the conditions of the European Union, its member states voluntarily give up their own currency on the basis of an international legal obligation which forms part of their Accession Treaty.

3. Research objective and methodology

3.1 Research aim

The main goal of the scientific article is to study and identify the Bitcoin price develop process, as the basic cryptocurrency, in relation to the basic stock market's indicators - gold price. This study is also done to predict the tendency of the BTC price by simulation model created on the basis of the statistical analysis of observed data. And finally the paper can be useful in decision making for investors, risk management, speculators, entrepreneurs who do business about cryptocurrencies market. All figures and tables are own source.

3.2 Research question and hypothesis

In short, this research study attempts to answer the following research questions: Is there a significant relationship between the value of basic cryptocurrencies and movements in gold prices? Does the value of Bitcoin, the most commonly used cryptocurrency depend on the price fluctuations from gold markets? Based on the set research aim, the research hypothesis was defined.
Research hypothesis H1: It can be stated that with the rising price of basic stock market's commodities (gold), the price value of Bitcoin increases (BTC as chosen basic cryptocurrency).

3.3 Research Methodology

To achieve the research aim we have studied the secondary obtained data, particularly the reports from the subject areas within the European Union and Slovakia during the observed period 2003 – 2018. The observation and

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evaluation of secondary obtained data was performed by usage methods suitable for processing this type of date. We present time series and correlation coefficients.

3.3.1 Time series analysis and time series analysis using neural networks

It is obvious to process large quantity of numbers and data to solve some research problems in economy, so extensity and complexity of calculations requires the usage of special methods and ICT technologies during the analysis. Time series analysis is one of the most important applications of statistical methods in economics. Time Series analysis is useful to study the relationship between different details and times. A time series is a chronologically arranged sequence of values, which are denoted in one of the following ways y1, y2,..., yn, or yt, t = 1 ,2,..., n. The basic assumption is that the time series consists of the following components: trend, seasonal, cyclical and random component. Depending on which mathematical operation is used to connect these components, we distinguish between additive, multiplicative and mixed models. In the following we will assume the following additive model: Yt=Ct+Et , hence a model with cyclic and random components. Both of components will be modeled and predict separately. Finally, the sum of individual components will lead to the resulting model and predictions.

3.3.2 Correlation coefficient

Correlation coefficient is used to measure the degree of association between two variables. The sample correlation coefficient (also known as the Pearson product moment correlation coefficient) measures the strength of linear association between two variables and it is used for a set of paired data observations (xi, yi) under the assumption that both variables have a normal distribution. Pearson coefficient is influenced by extreme values (outliers) that can amplify or dampen the strength of the relationship. The Spearman coefficient is used for the cases with extreme values.

4. Results and discussion

In accordance with the research aim, the input data set consists of time-varying values (in USD) of selected cryptocurrencies (Bitcoin) and time-varying values (in USD) of basic trade commodities (gold) - Table1. Bar chart of the highest and lowest price of Bitcoin in the observed period from 29.4.2013 to 03.04.2020 (Figure 1)-

Table 1. Descriptive statistics of the cyber currency Bitcoin in the monitored period from 29.04.2013 to 03.04.2020

	Open price (USD)	High price (USD)	Low price (USD)	Close price (USD)
Valid N	2532	2532	2532	2532
Mean	3260.34	3348.04	3165.01	3262.85
Median	774.39	786.75	765.14	776.21
Minimum	68.50	74.56	65.53	68.43
Maximum	19,475.80	20,089.00	18,974.10	19,497.40
Lower	383.99	392.13	375.34	384.01
Upper	6454.12	6546.84	6351.95	6463.21
Percentile 10	230.20	233.50	226.48	230.06
Percentile 90	9056.92	9334.87	8799.84	9055.53
Range	19,407.30	20,014.44	18,908.57	19,428.97
Quartile	6070.14	6154.71	5976.62	6079.20
Std.Dev.	3841.18	3960.07	3702.10	3841.28
Skewness	1.16	1.19	1.10	1.15
Kurtosis	0.50	0.65	0.25	0.50

Source: own elaboration

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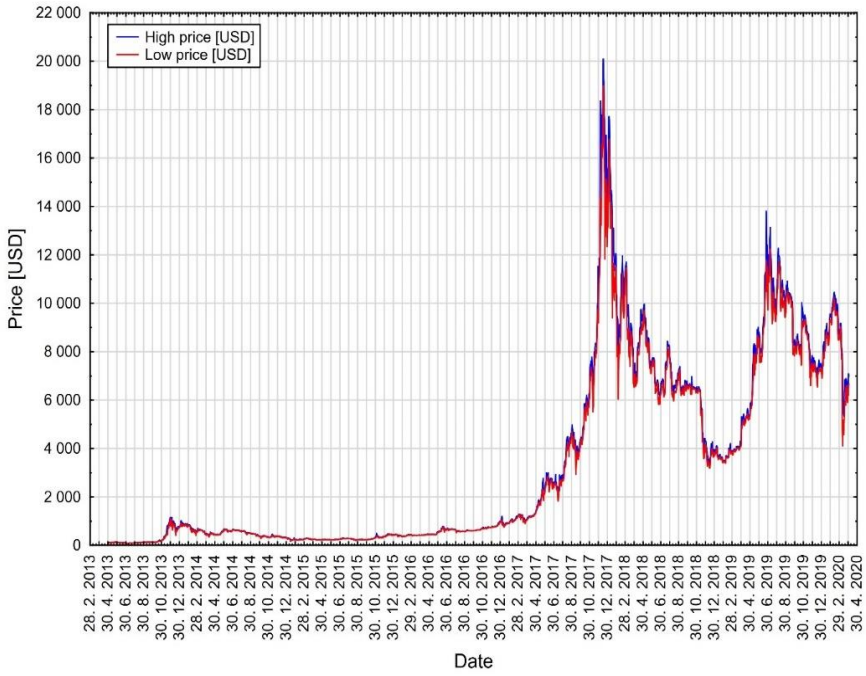

Figure 1. Bar chart of the highest and lowest price of Bitcoin in the observed period from 29.4.2013 to 03.04.2020

Source: own elaboration

4.1. Time Series Analysis

Mixed integrated ARIMA models are designed to describe time series with random trend changes. However, the initial time series does not have to be stationary, but it is necessary that it can be converted to a stationary time series. This conversion is made by differentiating the initial time series. The mixed integrated ARIMA process (*p*,*d*,*q*) is generally described by the model:

$$\varphi(\mathrm{B})W_t = \vartheta(\mathrm{B})\varepsilon_t \tag{1}$$

in which

$$W_t = \Delta^d Y_t \tag{2}$$

where W_t represents a time series constructed by differentiation the initial time series Y_t and d is the order of differentiation and is the difference operator defined as:

$$\Delta^d Y_t = (1-\mathrm{B})^d Y_t \tag{3}$$

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Model ARIMA (*p,d,q*) can also be written in the form:

$$\varphi(B)(1-B)^d Y_t = \vartheta(B)\varepsilon_t \quad (4)$$

The construction of a mixed integrated model is implemented in two steps:

1. First, the non-stationary time series Wt is converted by differentiation, or more precisely, by a suitable transformation to the time series Yt. Of course, it is necessary to realize that the initial time series works with this difference.
2. The mixed ARMA model (p, q) is applied to the stationary time series. Seasonally mixed integrated SARIMA processes are used to describe time series whose trend and seasonal component have a stochastic character. Assuming that we have a series of Yt monthly observations that show significant seasonal effects with the number of seasons L=12 during the year.

1. The first step is the construction of the ARIMA model for January observations in the form:

$$\Phi(B^{12})\Delta^D Y_t = \Theta(B^{12})\eta_t$$

where

$$\Phi(B^{12}) = 1 - \Phi_1 B^{12} - \Phi_2 B^{24} - \ldots - \Phi_P B^{12P}$$

is a seasonal autoregressive operator of the P and

$$\Theta(B^{12}) = 1 + \Theta_1 B^{12} + \Theta_2 B^{24} + \ldots + \Theta_Q B^{12Q}$$

is a seasonal moving sum operator of the Q and

$$\Delta_{12} = 1 - B^{12}$$

is the seasonal differential operator to which applies $\Delta_{12}^D Y_t = (1-B^{12})^D Y_t$.

During the creating process of a suitable model, e.g. if it is selected model ARIMA (p,d,q), which is based on ACF and PACF, it is necessary to define the adequacy measures of the model. The residual analysis of the created model is usually based on the fact, that the residues of an adequate model should be basically white noise only. Therefore, the statistical significance of residues autocorrelations is checked and compared to two standard error limits, i.e. $\pm\frac{2}{\sqrt{n}}$.

For completeness, we will consider the seasonal model ARIMA (AR(p) – where p is the degree of autocorrelation, represents weighted moving averages for the previous period, I(d) – where d is the degree of integration (differentiation), indicates a linear or polynomial trend, MA(q) – where q is the order of the moving average, indicates weighted moving average for past errors). The analysis of the cybernetic currency Bitcoin due to the need for high computational power and the possibility of gradual verification of the prediction model will be analyzed every year, followed by an analysis of the entire period under study. Due to the nature of ARIMA seasonal models, 4086 models were analyzed for each year.

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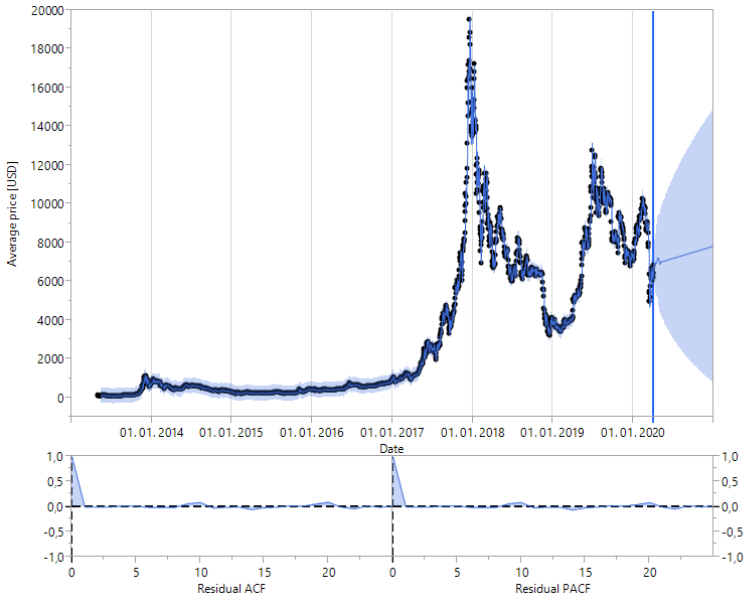

Figure 2. Model SARIMA (2,1,3)(3,1,2) of the Bitcoin Average price over all studied period

Source: own elaboration

Based on the performed analysis it can be stated, that the most appropriate model describing the time series of the Bitcoin Average price over observed period, i.e. from 29 April 2013 to 03 April 2020, is the SARIMA model (2,1,3)(3,1,2)12. The AIC value is of 33866.345 and it is the smallest value for all models from the studied interval of the second step. The SBC (BIC) value is 33930.493 and this value is the second smallest value for the models from the observed interval.

The indicator value MAPE, i.e. the Mean Absolute Percentage Error is 2.304480 and the value of M.A.E. i.e. the mean absolute error of the residues is 81.031849. In the Figure 2 we can see a graphical representation of the SARIMA (2,1,3) (3,1,2) model, including the prediction and also values of the residual autocorrelation and residual partial autocorrelation function. Figure 3 depicts the error of the SARIMA (2,1,3) (3,1,2) model compared to the real prices of the cryptocurrency Bitcoin in the entire monitored period from 29 April 2013 to 3 April 2020.

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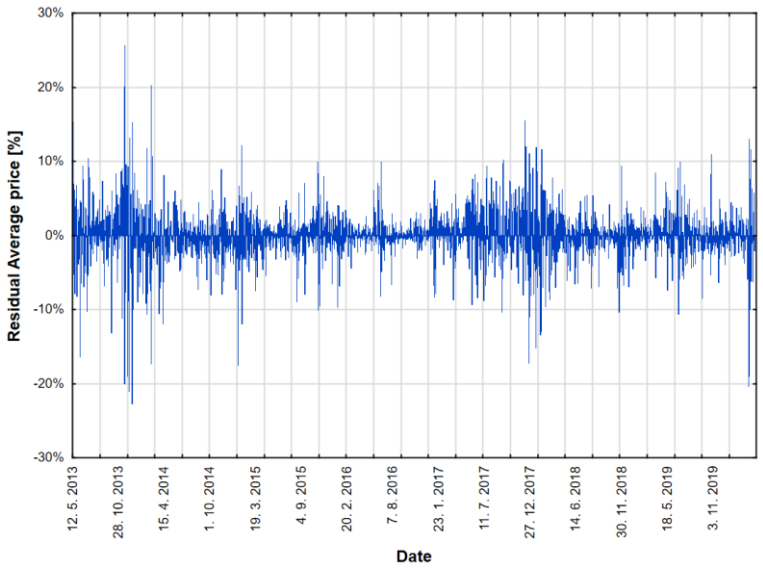

Figure 3. Error of the SARIMA model (2,1,3)(3,1,2) of the Bitcoin Average price over all examined period

Source: own elaboration

The average value of residuum between the actual average value of the price of the cryptocurrency Bitcoin during the whole observed period and the value of the cryptocurrency Bitcoin calculated by model SARIMA (2,1,3) (3,1,2) is 0.021% with a standard deviation of 3.49%. The minimum deviation value is -22.7% and the maximum deviation value is 25.7%. The lower quartile represents a value of -1.44% and the upper quartile 1.51%. The mean (middle) value of observed data set is expressed by the median, which value is 0.00257%. Median has occurred a better representative of mean value than the arithmetic mean according to the results of Shapiro-Wilk test, the achieved value of significance p=0.00001. The basic characteristics of the reference model SARIMA (2,1,3) (3,1,2) are given in Table 2.

Table 2. Summary of model SARIMA (2,1,3)(3,1,2) 2013-2020

Parameter	Value
DF	2508
Sum of Squared Errors	98157013
Variance Estimate	39137.565
Standard Deviation	197.832164
Akaike's 'A' Information Criterion	33866.3451
Schwarz's Bayesian Criterion	33930.4929
RSquare	0.99732781
RSquare Adj	0.99731715
MAPE	2.30448005
MAE	81.0318485
-2LogLikelihood	33844.3451

Source: own elaboration

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It should be noted here that the SARIMA (2,1,3) (3,1,2) model describes the real values of the average price of the cryptocurrency Bitcoin with an accuracy of 99.732%. The basic characteristics of the reference model SARIMA (2,1,3) (3,1,2) are shown in Table 3.

Table 3. Model SARIMA (2,1,3)(3,1,2) 2013-2020

Term	Factor	Lag	Estimate	Std Error	t Ratio	Prob>|t|
AR1,1	1	1	-0.70121	0.081216	-8.63	<.0001*
AR1,2	1	2	0.134985	0.060959	2.21	0.0269*
AR2,12	2	12	-0.45586	0.122721	-3.71	0.0002*
AR2,24	2	24	-0.09347	0.022858	-4.09	<.0001*
AR2,36	2	36	-0.12268	0.020478	-5.99	<.0001*
MA1,1	1	1	-1.02359	0.079951	-12.8	<.0001*
MA1,2	1	2	-0.09525	0.077416	-1.23	0.2187
MA1,3	1	3	0.091595	0.024954	3.67	0.0002*
MA2,12	2	12	0.594213	0.123472	4.81	<.0001*
MA2,24	2	24	0.405787	0.123248	3.29	0.001*
Intercept	1	0	0.006029	0.038465	0.16	0.8755

Source: own elaboration

Based on the developed time series model SARIMA (2,1,3)(3,1,2)2013-2020, which was created on the basis of Bitcoin Average price data set during the observed period from 29 April 2013 to 3 April 2020, we were able to predict the Bitcoin price. In the Figure 4 is displayed a prediction of the price of cryptocurrency Bitcoin for time range from 04 April 2020 to 29 June 2020 and also the actual market value of Bitcoin.

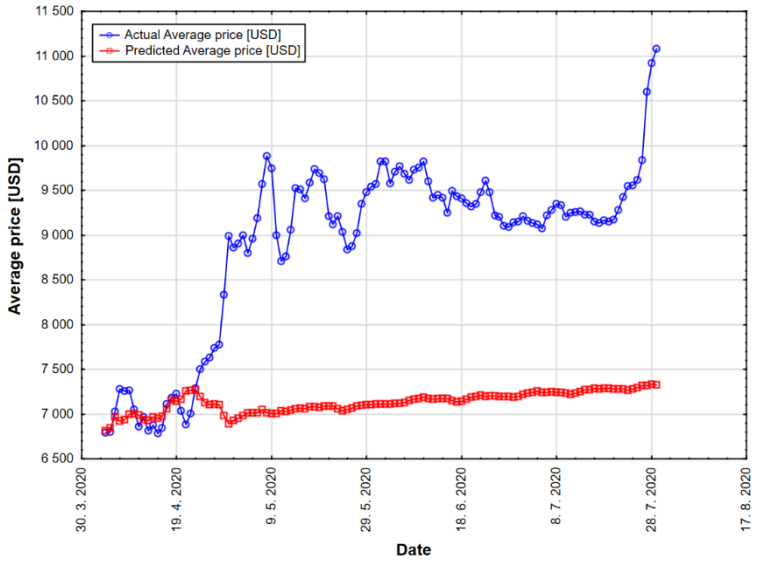

Figure 4. Predictive model SARIMA (2,1,3)(3,1,2) 2013-2020 from 04 April 2020 to 29 July 2020

Source: own elaboration

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From graphically presented information in Figure 4, about actual and predicted average price of Bitcoin, it is clear that in the interval of about 15 days from the beginning of the model verification, the model SARIMA (2,1,3) (3,1,2) 2013-2020 can fairly accurately and effectively describe the actual market prices of the cryptocurrency Bitcoin. With increasing time, however, the predictive power of the SARIMA (2,1,3) (3,1,2) 2013-2020 model decreases sharply, which can also be attributed to the very rapidly changing situation on the stock exchange of individual economies caused by the global pandemic COVID- 19.

The differences between the actual market price of the cryptocurrency Bitcoin and the price predicted by the created model SARIMA (2,1,3) (3,1,2) 2013-2020 is displayed in Figure 5. The average value of residuals is 18.80% with the residual standard deviation of 9.71%. The minimum residual value (min residuum) is -5.36% and the is 33.9%. The value of the lower quartile of residuum is 20.2% and of the upper quartile 24.6%. The mean value expressed as a median is 21.9%.

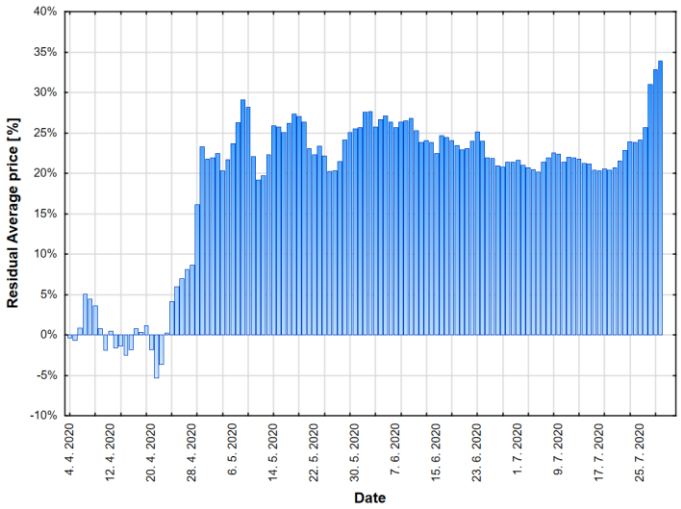

Figure 5. Bitcoin price prediction error by the model SARIMA (2,1,3)(3,1,2) 2013-2020 from 04 April 2020 to 29 July 2020

Source: own elaboration

In accordance with the chosen confidence interval of individual members of the created model SARIMA (2,1,3)(3,1,2)2013-2020 it is possible to simulate different behavior of studied data during the observed time period from 04 April 2020 to 29 July 2020 (Figure 6).

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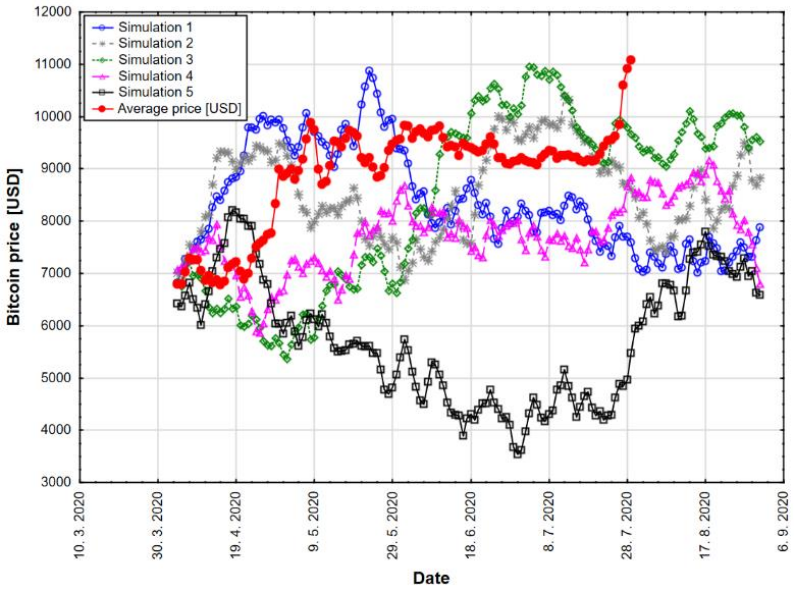

Figure 7. Simulation of Bitcoin average price by the model SARIMA (2,1,3)(3,1,2) 2013-2020 from 04 April 2020 to 29 July 2020

Source: own elaboration

Table 4 implies that simulation 2 appears to be the most suitable simulation. Applying this simulation the average value of residuals between simulated and real data is 1.349% with a minimum value of -37.592% and a maximum value of 29.952%.

Table 4 . Model SARIMA (2,1,3)(3,1,2) 2013-2020

Variable	Descriptive Statistics (Simulation - prediction)						
	Valid N	**Mean**	**Median**	**Minimum**	**Maximum**	**Lower Quartile**	**Upper Quartile**
Sim 1	117	1.082%	5.216%	-39.632%	31.492%	-8.497%	12.525%
Sim 2	117	1.349%	1.750%	-37.592%	29.952%	-7.314%	14.376%
Sim 3	117	8.744%	7.913%	-19.987%	41.964%	-5.093%	23.799%
Sim 4	117	14.725%	16.833%	-15.334%	31.774%	12.942%	19.887%
Sim 5	117	37.060%	46.085%	-16.763%	61.265%	32.057%	52.648%

Source: own elaboration

4.2. Correlation analysis of the observed variables

The strength of linear association between two jointly distributed random variables X and Y is measured and defined by the correlation coefficient rxy, which takes a value between -1 and 1. A sample correlation coefficient rxy=0 (or is very close to zero) indicates that there is no linear association between the two variables, and their distributions can then be thought of as being independent of each other. The closer the sample correlation coefficient is to either 1 or -1, the stronger is the linear association (in case of 1 there is a strong positive linear association between two variables, in case of -1 it is interpreted as strong negative linear association). Correlation of ± 0,5 are interpreted as relatively weak linear association.

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Let assume that we have a set of n paired data observations (xi, yi) of two random variables X and Y, i=1,2,..., n. Then the strength of linear association between the two variables X and Y is measured by the sample correlation coefficient rxy defined as:

$$r_{xy} = \frac{\mathrm{cov}(xy)}{\sigma_x \cdot \sigma_y} \tag{5}$$

where cov (xy) represents covariance of X and Y, is a standard deviation of X and is a standard deviation of variable Y. Covariance coefficient of X and Y is defined by the formula: $\mathrm{cov}(xy) = \frac{1}{n}\sum_{i=1}^{n}\left(x_i - \bar{x}\right)\cdot\left(y_i - \bar{y}\right)$

Setting this to the formula for r_{xy} we obtain:

$$r_{xy} = \frac{n\cdot\sum_{i=1}^{n} x_i \cdot y_i - \sum_{i=1}^{n} x_i \cdot \sum_{i=1}^{n} y_i}{\sqrt{n\cdot\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2}\cdot\sqrt{n\cdot\sum_{i=1}^{n} y_i^2 - \left(\sum_{i=1}^{n} y_i\right)^2}} \tag{6}$$

Table 5 presents correlation coefficients between examined variables (Gold vs Bitcoin, Gold vs Ethereum, Gold vs XRP), average price was taken into account. The results listed in Table 5 confirm that there is a positive linear association between average price of gold and average price of selected cryptocurrencies (Bitcoin, Ethereum, XRP). Moreover, in all cases this association is statistically significant at the significance level of α = 5%. According to Cohen scale there occurs a strong linear association (0.5-0.7) between Bitcoin Average price and Gold Average price, the value of the correlation coefficient in this case reaches 58.85%. Reflecting the Cohen scale (0.1-0.3), there is a weak linear association between the average price of the cryptocurrency Ethereum and the average price of gold, the value of correlation coefficient is 0.1729 in this case. A weak linear association is also between XRP Average price and Gold Average price, the correlation coefficient is 0.1100.

Table 5. Correlation analysis between observed cryptocurrencies and gold (average price).

Variable	Correlations Marked correlations are significant at p < ,05000 N=1299		
	Average price (USD)- Bitcoin	**Average price (USD) - Ethereum**	**Average price (USD) - XRP**
Average price (USD) - GOLD	0.5885	0.1729	0.1100
	p=0.000	p=0.000	p=0.000

Source: own elaboration

Based on the results presented in Table 5 we can confirm and accept the hypothesis H1 mentioned above. Summary of the research hypothesis H1 verification: based on the performed statistical analysis it can be concluded that the research hypothesis H1 is accepted.

Cryptocurrencies as a phenomenon of these days are governed by their own rules (Bulinska-Stangrecka and Bagieńska 2019), but with the use of mathematical-statistical analysis it is possible to predict their future development and their mutual relations, although with only a limited time advance. It is also possible to define the relationship between the studied cryptocurrencies and currently one of the most stable market commodities, gold. Both the average price of gold and the average price of the investigated cryptocurrency Bitcoin, as the most famous cryptocurrency, is nowadays in a very unstable state associated with the global pandemic COVID-19, as it is evidenced by high values of prediction residuals for individual cryptocurrencies. However, the movement in the prices of cryptocurrencies is not only dependent on time, but is also influenced by a number of other factors: economic, political and others. In any case, cyber currencies hold an irreplaceable place in the money market and

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therefore, in the future, it is absolutely necessary to create complex models with consideration of other significant effects on the changes in their prices.

Taken a look at Bitcoin's responses to macroeconomic events during 2020, we can say that it has fulfilled its role as a value holder. In the period under review (31.10.2020), about 35% is trading above the pre-crisis price and 100% above the January 2020 price. Unlike gold, which has increased in value by around 25% since the new year. The current price of $ 13,900 (€ 11,900) has already surpassed the 2019 maximum and is approaching a historical maximum. In case of interest, it is possible to buy only a part of Bitcoin (at least 0.00000001 BTC).

The advantage of Bitcoin over gold is also in its storage. If the applicant wants to buy physical gold, he must pay extra. And when selling, he pays again. Bitcoin can be bought on the stock exchange at any time at the current market value, sent to a wallet in your laptop, mobile, or even a paper wallet, and unless the entire Internet (and with it our civilization) is permanently collapsed, purchased coins are only theirs and no one will ever take those from them. Of course, it is possible to argue that in the case of the apocalypse, the owner can't do anything with some virtual coins but it is appropriate to add that even gold isn't very useful in that scenario. Owner will have to sell it or exchange it for something of real value, and there is no guarantee that there will be interest in this precious metal in post-apocalyptic civilization (Gruenbichler et al. 2021).

5. Conclusions

Information in this paper could be useful also for risk management, which is the process of identifying, assessing and controlling threats to an organization's capital and earnings (Bulinska-Stangrecka and Bagieńska 2018, Lu et al. 2021). These threats, or risks, could stem from a wide variety of sources, including financial uncertainty, legal liabilities, strategic management errors, accidents and natural disasters (Milošovičová et al. 2018, Meyer et al. 2017, Hussain et al. 2020, Gavurova et al. 2018, Gavurova et al. 2020a, Kocisova et al. 2018). The study also provides many insights and perspectives that can inspire and encourage further research into financial, economic and innovative aspects in other sectors (Gavurova et al. 2020b, Gavurova et al. 2021a, Gavurova et al. 2021b, Kelemen et al. 2019, Polishchuk et al. 2019).

In 2020 factors such as the global pandemic, financial uncertainty, and the election in the USA have seen an increase in the Bitcoin correlation to gold and the stock market. The forex market is renowned as the single most volatile financial entity of its type, and there are several factors that contribute to this. One of the most pressing is the diverse range of macroeconomic factors that impact on currency values, including domestic and international monetary policy. Increased public spending has also begun to impact on precious metals and stocks, while we've also seen a strong correlation between the performance of these assets and Bitcoin (Peracek et al. 2020). Bitcoin, however, seems to be very susceptible to the price fluctuations from gold markets.

Historically, Bitcoin (which remains the world's market-leading cryptocurrency with a total market cap of approximately $193 billion) has enjoyed a loose relationship with other assets.

However, there are signs that this may be changing as the coronavirus continues to grip the financial markets, with the research teams having previously highlighted a 70% correlation between Bitcoin and gold price declines on multiple occasions. This trend has coincided with the decline of major currencies and their value, and it has become particularly pronounced throughout 2020. In July, the Bitcoin correlation to gold and stocks had peaked at all-time highs globally (Sopiah et al. 2020), highlighting the growing maturity of the asset and its rate of adoption across a diverse range of markets. Bitcoin seems to be very susceptible to the price fluctuations from gold markets. Bitcoin is starting to behave more like a store of value and is potentially being used as a safe-haven asset during global uncertainty in traditional markets.

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