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Prediction of the Future Development of Gold Price

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Abstract
Gold belongs, thanks to its extraordinary qualities, to the most interesting and well-known precious metals as far as investment is concerned. The paper aims to estimate the future development of the gold price and determine whether the gold price actually increases in times of economic recession. For the purpose of the analysis, data about the daily gold price from 2006 to July 2020 is used. To elaborate this paper, five methods of time series balancing were employed, namely Neural Networks, Decision Tree, Gradient Boosted Tree, Linear Regression, and Nearest Neighbours. The methods are applied to a training data set, and the final model is tested on the testing data set. The respective models' residues are presented in a graphic form as well as the Probability Density Histogram, Training Data Set Residues Histogram, and a graph of testing data set residues. The future development of the gold price for the next calendar year is predicted. Market participants buy gold in the first moments of the economic recession in order to keep the value of their property. Consequently, however, they lack cash and are forced to sell the gold again. A similar development can be expected now too. A global economic recession can be expected. Debtors will have to get rid of their investments, which will cause the gold price to fall dramatically. The gold price reaches its maximum value at the end of the observed period; then, it should decrease progressively to the end of 2020. At the beginning of 2021, the price should slump. Then, in the following six months, it should follow a growth path again.

Keywords
Gold price, prediction, global economic recession, state precautions, liquidity

Introduction

The fast and dynamic development of the global economy provides the investors with a number of new opportunities for depositing their available financial means, according to Vrbka and Rowland (2017). As it is stated by Marecek and Machova (2017), one of these opportunities can be represented, for example, by investing in precious metals. Rehman et al. (2018) observe that the awareness of precious metals as a tool of investment increased mainly after the financial crisis in 2008-2009 as a result of the so-called "flight to security" tendency on the commodity market. Out of these commodity markets, mainly gold but also other precious metals such as silver, copper, platinum, or palladium were historically used as safe assets and value preservers (Vigne et al., 2017). In order for metals to carry the attribute "precious", they have to fulfill some criteria such as fineness, relative rarity, homogeneity, high durability, and easy divisibility, according to Endou et al. (2000). As for other qualities of precious metals, according to Hammoudeh and Yuan (2020), the metals have to dispose of high weight, conductivity, or a high mechanic resistance. However, the main quality distinguishing precious metals from other commodities is their limited amount. Moreover, it is exactly a limited amount, and the steadily increasing demand results in their increasing importance (Dutta, 2018). Currently, precious metals are used in a wide scale of use not only for electronics and communication devices, engines of spaceships, and jet planes but also for cell phones and catalytic converters. The most common metals are gold from jewelry and electronics, silver from electronics, radiography, film, and photographic emulsions, jewelry, and industrial application; metals such as platinum from catalytic converters for refining oil, etc. (Canda, Heput and Ardelean, 2016).

Mirmirani and Li (2004) do not doubt that one of the most interesting and well-known metals as far as investments are concerned is gold. Thanks to its extraordinary qualities such as divisibility, rarity, ability to treasure, etc., gold plays a very important role in monetary systems and is considered to be a symbol of wealth for a couple of thousand years (Tri and Nga, 2019). Vravec (2012) adds that gold resists acids, salts, and rusting very well; it is chemically stable, soft, ductile, malleable, and functions as a great conductor of warmth and electricity. Investors consider it to be some sort of a "safe haven" at times of economic crises, which is also reflected by its price development on commodity markets (Ismail, 2009). Gutiérrez, Franco and Campuzano (2013) observe that the history of actual gold trading dates back to the 14th century. Furthermore, the author adds that gold played the role of a financial guarantee for issued banknotes, and later, it served as a tool of exchange trade in the 19^{th} and 20^{th} centuries. Later on, other types of investments, such as stocks or commodities, joined gold on the market. For the purpose of trading gold on the stock market or its storage for bank purposes, gold is calibrated into a weight unit. The gold price is given in USD for Troy ounce corresponding with approx. 31.1034768 grams. Gold is distinguished according to its fineness, in which case the gold with the highest level of fineness 99.99 is considered to be suitable for investment purposes (Tully and Lucey, 2007).

Part of the paper is literary research, including a literature review on the topic of predicting the future development of the gold price. Furthermore, the used data are described, including basic statistical characteristics, and the used methods – Neural Networks, Decision Tree, Gradient Boosted Tree, Linear Regression, and Nearest Neighbors are described. In the result part, the time series is first balanced by all the above methods. Furthermore, the balanced time series are compared with the actual course of the gold price. The Probability Density Histogram is used to identify the most accurate method, and a histogram of the residues of the training data set and the graph of the testing data set residues. The final gold price prediction is given. The next section discusses the development of the gold price and the future development of the gold price. In the end, the results, limitations, and directions of future research are briefly summarized.

The aim of the paper is to estimate the future development of gold prices.

With regard to the conducted literary research, we set the following research questions:

1. Does the gold price increase in the period of recession?
2. What kind of development of the gold price can be expected in the time period to 8th July 2021?

Literary Research

Arouri et al. (2012) claim that empirical studies focusing on precious metals can be divided into two main research lines. The first one is oriented on macroeconomic determinants of precious metals, and the second one concentrates on modeling and prediction of precious metals volatility. According to Paramita, Vivekananda and Debasmita (2017), it can be observed that the research in the field of demand for gold as the essential economic variable has been attracting the researchers' attention for ages. During this time, a number of studies and research have been conducted to identify the microeconomic and macroeconomic factors influencing the demand for gold (Balagopal and Sanket, 2018). Baur and McDermott (2010) add that the recent collapse of financial and economic conditions in the USA and European countries contributed to the motivation to study gold as a safe haven from a shortage of financial markets.

Some of the authors dealing with the issue of demand for gold are, for example, Starr and Tran (2008), who were the first ones to provide complex research of the factors influencing the physical demand for gold using panel data covering 21 countries in the years 1992-2003. They discovered that the persisting heterogeneity in physical demand for gold across nations is in accordance with the influence of socio-cultural aspects. Furthermore, the determinants of physical demand for gold differ from determinants of the same demand for portfolios, and they also differ in cases of developed and under-developed economies.

O'Connor et al. (2015) state that, according to a number of studies, gold is considered to be an investment asset in which case its significance in the portfolio diversification and its role as a safe haven in times of turbulences and crises on financial markets is emphasized. Also, Baur and Lucey (2010) identify with this statement, who observes that, during extreme conditions on financial markets, gold seems to be the right tool for securing the supplies. Beckmann, Berger and Czudaj (2015) add that this effect differs in individual countries. Cohen and Quadan (2010) analyzed the mutual dependence of the gold price and volatility index (VIX). They found that, during highly volatile time periods, the former leads the latter, which means that gold plays the role of some sort of a safe haven during the periods of stress on oil market or during extreme fluctuation of the exchange rate of the USD (Reboredo, 2013a; Reboredo 2013b). Tran and Starr (2007) examined the role of gold in exchange and monetary policy in Vietnam where, in the turbulent time period after the start of economic reform, gold served not only to preserve the value but also as an accounting unit and, for some types of transactions, as an exchange medium.

Baur (2016) discovers that coordinated purchases and sales of gold by central banks have an asymmetric effect on the gold price, which results from their ability to keep the price limit but not the price ceiling.

Balagopal and Sanket (2018) use their research to examine further the influence of global risk on the possession of gold by central banks. The research was conducted on the basis of yearly data for the time period 1990-2015 on a sample of 100 different countries. For the purpose of the study, the authors use the dynamic panel generalized method of movements model observing a number of factors. In accordance with the portfolio diversification and perception of gold as a safe asset, it was discovered that the possession of gold by central banks increases in reaction to higher global risk (Sinicakova and Gavurova, 2017). This effect differs depending on the openness of capital accounts, adequacy of reserves, state of income, and monetary regimes (Sinicakova et al., 2017). These findings indicate that central banks adjust their possession of gold in reaction to changes in global risk conditions, in which case the extent of the reaction depends on the vulnerability of the respective country. Karunagaran (2013) concentrates on the general trend of central banks' demand for gold as a consequence of a recent global financial crisis and observes that the demand for gold increases in the period of crisis. In the study, the issue of the optimal amount of gold in foreign exchange reserves and the reasons for banks buying gold with regard to the global crisis are discussed as well.

Materials and Methods

For the analysis of the time series and, subsequently, for the prediction of the future development of the gold prices, the London Fix Price AM data are used as standard. The key value for setting the reference gold price is the so-called London Fix Price, also known as London Golden Fix or London Fix. The gold price is determined twice a day on business days of the London Commodity Stock Exchange (i.e., apart from bank holidays). Since 1919, it has been set in cooperation with the five biggest traders on the stock market (Scotia-Mocatta, Barclays Capital, Deutsche Bank, HSBC, and Société Générale). London Fix is set twice a day – the morning publication at 10:30 a.m. GMT called AM and the afternoon publication at 15:00 p.m. GMT called PM.

The process of establishing the London Fix is as follows: the lead participant proposes an opening price near the current spot price. Subsequently, the participants contact their sales department and negotiate the number of gold ingots sold and bought for this particular price. The price can be slightly adjusted in order for the supply and demand of these five business subjects was in equilibrium without any significant excess of supply and demand. Consequently, the London Fix is set. The whole process usually takes about 10 to 20 minutes. The London Fix Price is set in USD, GBP, and EUR for one Troy ounce (i.e., 31,1034807 grams). The biggest business subjects trade approximately 20 tons of gold for the set price; the information about the official amount is not available (Machova, Krulicky and Horak, 2020).

The data for this contribution was collected from the website kurzy.cz (Gold – the current price of gold, investment gold, 2020). Kurzy.cz calculates the gold exchange rate from several (moreover continuously changing) sources. In addition, they compare them with the Bloomberg and Reuters exchange rates. Therefore, the exchange rate, in this case, does not correspond to any specific stock exchange or broker; it is primarily an expression of the general tendency of the exchange rate. Dates in the time period from 3rd January 2006 to 8th July 2020, i.e., 3,663 entries about the gold price, will be examined. The gold price will be expressed due to the nature of the input data in CZK.

The following graph illustrates the development of the gold price in the observed time period in Figure 1.

Fig. 1. The development of gold price in the time period from 3rd January 2006 to 8th July 2020
Source: Gold – the current price of gold, investment gold (2020)

The gold price is given in CZK. In 2006, the price started at a value higher than 500 CZK. Subsequently, it grows. In 2011, the gold price for one ounce reached almost 1,900 CZK. Later, it progressively decreases up to the year 2016 when it grows to 1,800 CZK for ounce again. The development in 2008 is interesting as well. Compared to the previous year, the gold price increased significantly and held its value for the whole year 2008. This could indicate the situation, as mentioned above. Gold keeps the value and serves as a tool of treasuring. Therefore, it is more than logical that, at the time of economic recession, the demand for gold grows, resulting in an increase in the gold price. The descriptive characteristics of the observed time series are stated in Table 1.

Tab. 1. Characteristics of the data collection

Descriptive Characteristics	Value in CZK
Minimum	524.75
Maximum	1,895
Average	1,205.03
Middle Value	1,248
Variance	98,337.9
Standard Deviation	313.589

Source: Authors.

To elaborate this paper, the software Mathematica from the company Wolfram in its version 13, will be employed. Specifically, five methods for balancing the time series and, therefore, obtaining the development model of the observed time series will be used. The following methods will be applied:

1. Neural Networks: A neural network consists of stacked layers, each performing a simple computation. Information is processed layer by layer from the input layer to the output layer. The neural network is trained to minimize a loss function on the training set using gradient descent. This method uses a multilayer perceptron network, and the training determines the number of neurons in the hidden layer for one thing and the weight of individual neurons for another. The weight of the respective neurons intensifies or weakens the signal that is transmitted in the neuron structure. The number of neurons in the input layer is one in this case. It represents the number of input quantities. Given the fact that there is only one continuous variable at the input, the number of neurons in the input layer equals one. The output variable is continuous as well, and it is the only one. Therefore, there is one neuron in the output layer as well. The following functions will be employed to activate the hidden and output layer of neurons: linear, identical, sine, hyperbolic tangent, and logistic function.
2. Decision Tree: A decision tree is a flow chart-like structure in which each internal node represents a "test" on a feature, each branch represents the outcome of the test, and each leaf represents a class distribution, value distribution or probability density.
3. Gradient Boosted Tree: Gradient boosting is a machine learning technique for regression and classification problems that produces a prediction model in the form of an ensemble of trees. Trees are trained sequentially to compensate for the weaknesses of previous trees. The current implementation uses the LightGBM framework in the back end.
4. Linear Regression: the linear regression predicts the numerical output y using a linear combination of numerical features:

$$x=(x_1, x_2, \ldots, x_n). \quad (1)$$

The conditional probability $P(y|x)$ is modeled according to:

$$P(y|x) \propto exp\left(-(y-f(\theta,x))^2/(2\sigma^2)\right), \text{ with } f(\theta,x)=x.\theta. \quad (2)$$

The estimation of the parameter vector is done by minimizing the loss function:

$$\frac{1}{2}\sum_{i=1}^{m}(y_i-f(\theta,x_i))^2+\lambda_1\sum_{i=1}^{n}|\theta_i|+\frac{\lambda_2}{2}\sum_{i=1}^{n}\theta_i^2, \quad (3)$$

where m is the number of examples, and n is the number of numerical features.

5. Nearest Neighbours: Nearest neighbors is a type of instance-based learning. Its simplest form picks the commonest class or averages the values among the k nearest neighbors.

The methods will be applied to the training data set every time. This set will include two-thirds of the data collected from the observed time period, i.e., 2,442 entries about the gold price altogether. The testing data set will be working with 1,221 entries about the gold price. The obtained models will be presented in a graphic form. The illustrations will include a graph of the analyzed time series development and the predictions calculated by means of the acquired model. Furthermore, the residues of the individual models will be presented in a graphic form. In order to choose the most suitable prediction model, the results of the testing data set will be analyzed as well. Specifically, it is the case for:

1. Probability Density Histogram: a histogram of the differenced of the original time series probability density and the predictions. The final value always lies in the interval of the values $[y_j, y_m]$. The Probability Density Histogram is derived from the following formula:

$$P(y\in\left[y_j, y_m\right]=\int_{y_j}^{y_m} f_y(y)dy \quad (4)$$

provided that the relation

$$f_y(y)>0 f_y(y)>0, \forall y \text{ and } \int_{-\infty}^{+\infty} f_y(y)dy = 1. \quad (5)$$

2. Residue of the testing data set histogram
3. Residue of the testing data set graph

Finally, the future development of the gold price converted to CZK will be predicted for the next calendar year (258 business days in particular). This predicted development will be presented in the form of a graph as well.

Results

Based on the calculations, the time series was balanced by means of the five methods – the gold price given in CZK (see Figure 2). The graphs in Figure 2 provide a comparison between the balanced time series and the real course of the gold price. Pictures a to c reflect the actual development of the gold price. Every picture then includes all or chosen a balanced time series. The picture provides a comparison of the actual course of the gold price and the balanced time series of all methods employed. The Nearest Neighbours method seems to be the most interesting of all. This particular method is left out in the next picture. Consequently, we get the basic idea about the development of other balanced time series. Out of all, mainly the ones balanced using the Neural Network and Gradient Boosted Trees seem to be the most promising. This presupposition is confirmed by picture c as well, which does not include the time series balanced according to Linear Regression. The most successful method cannot, however, be chosen based only on one's perception. Figure 3 provides, therefore, a comparison of the respective balanced time series with the actual development of the gold price in CZK. The illustration provides insight into the predicted development for the 12-month period and the development of residues.

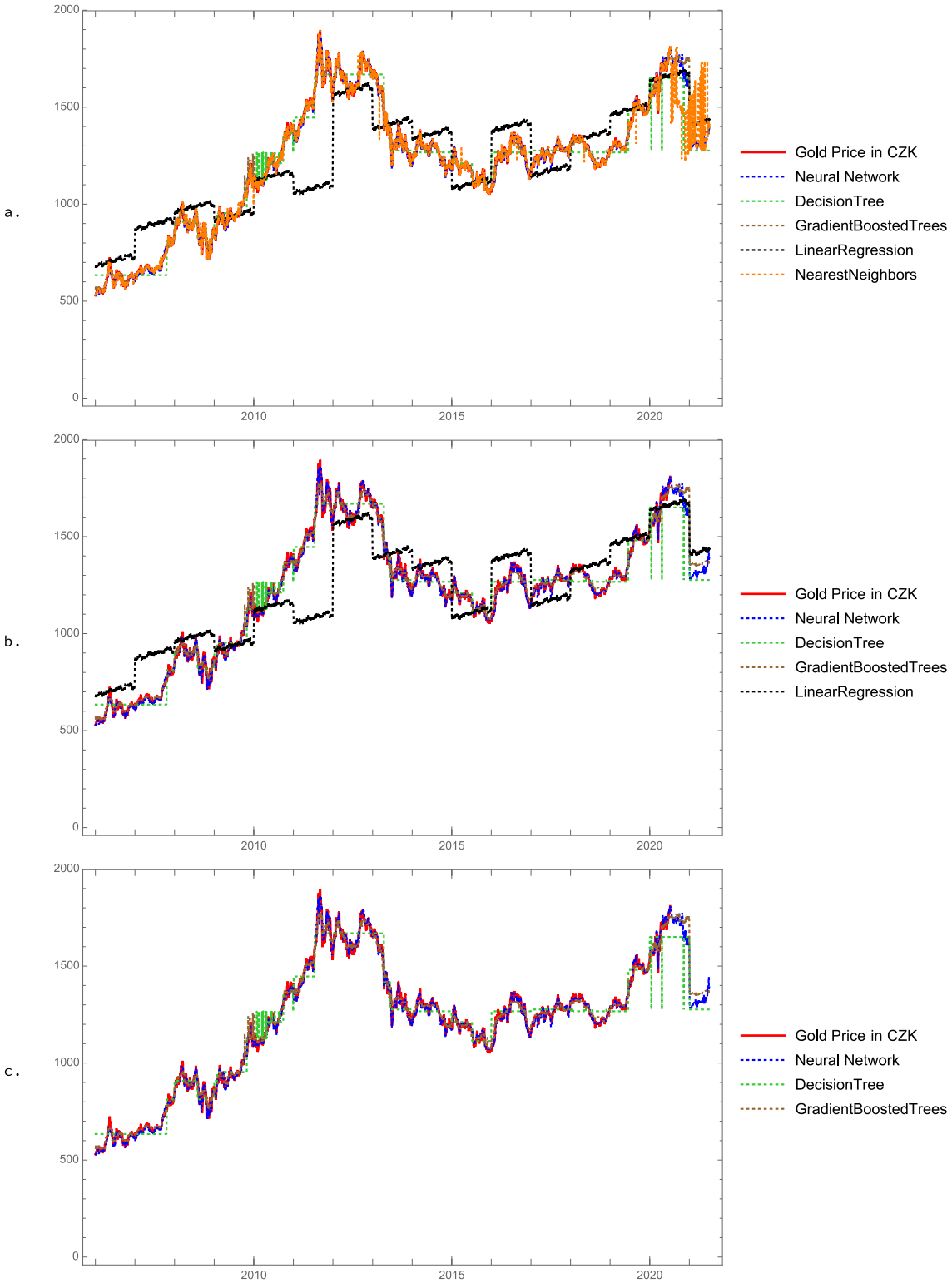

Fig. 2. The gold price given in CZK and the balanced time series
Source: Authors.

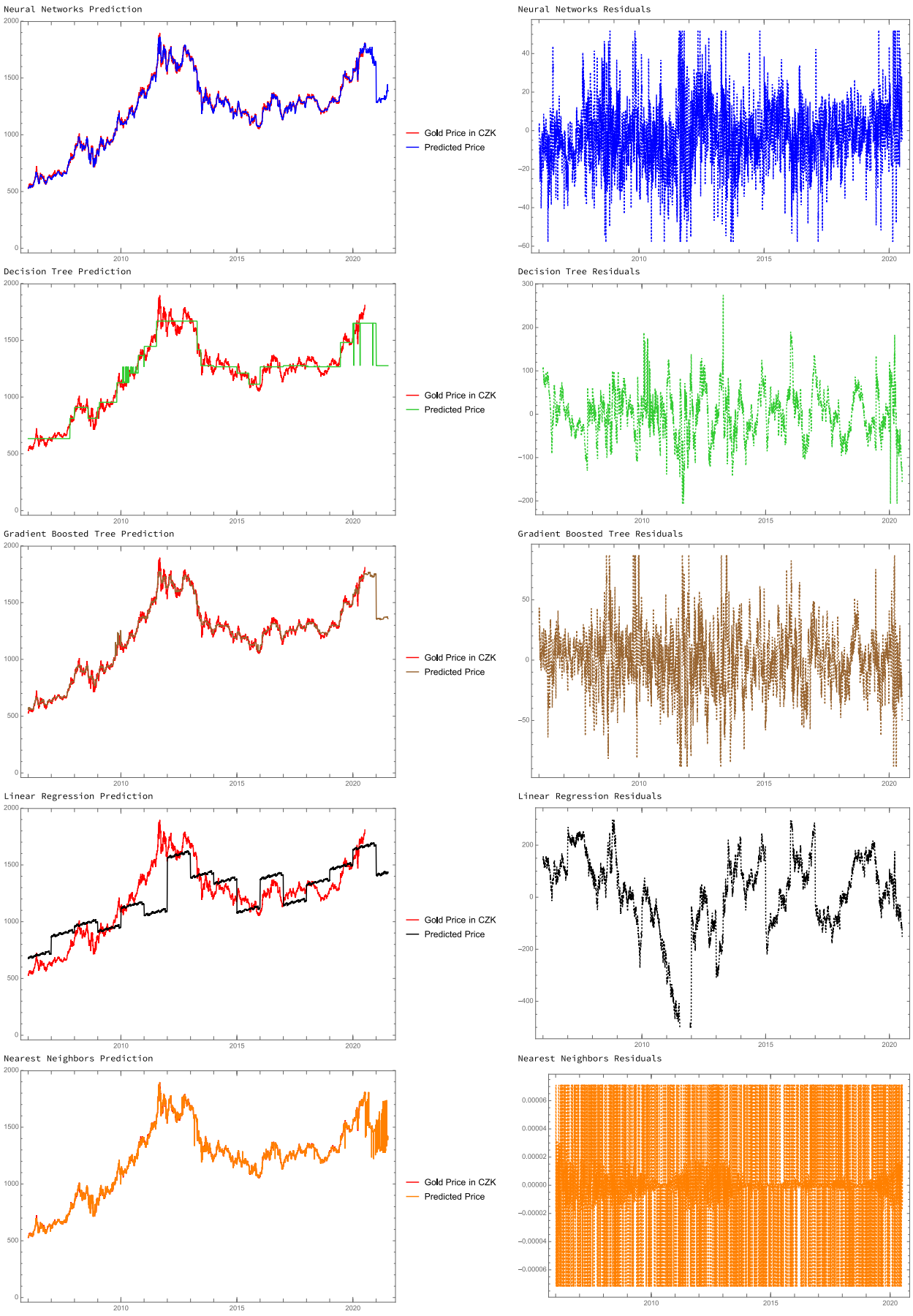

Fig. 3. Comparison of balanced time series with the gold price development, residues
Source: Authors.

The illustration shows that three methods are suitable for the analysis: Neural Network, Gradient Boosted Trees, and Nearest Neighbours. Although we will focus primarily on these three methods with more promising results, other methods will not be left out either. Taking into account the graphs in the right part of the illustration, a conclusion can be drawn that the method that was able to provide the best balance of the time series was the Nearest Neighbours method. Residues of this time series oscillate in the interval from -0.00006 to +0.00006 CZK for ounce. Residues of the Neural Network method range in the interval from -60 to +40 CZK for ounce. Residues of the Gradient Boosted Trees fluctuate even in the interval from -100 to +100 CZK for ounce. To identify the most accurate method, we use the Probability Density Histogram, a histogram of residues of the training data set, and the graph of testing data set residues (Figure 4).

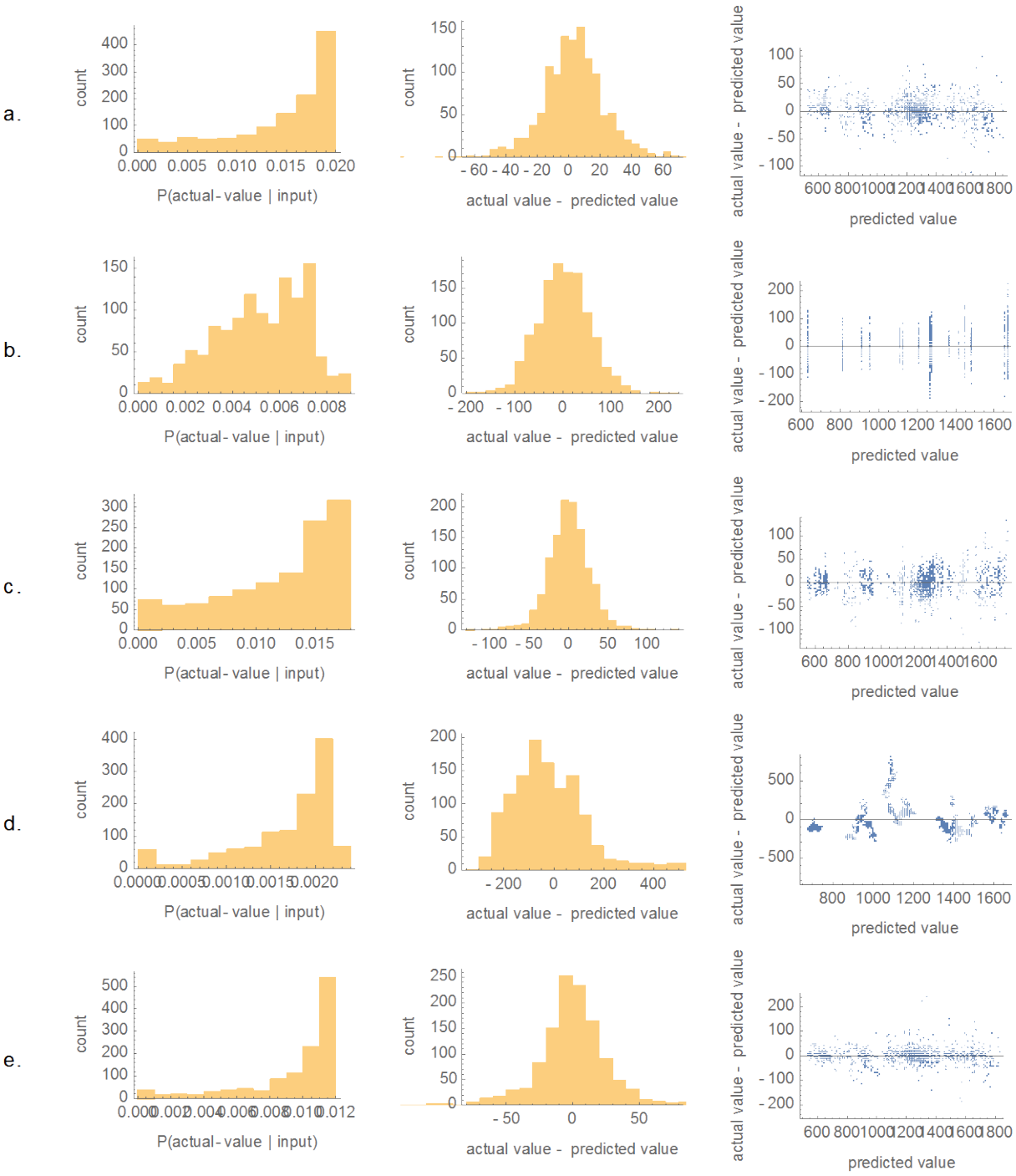

Fig. 4. Probability Density Histogram, a histogram of residues of the training data set and the graph of testing data set residues
Note: a. = Neural Network, b. = Decision Tree, c. = Gradient Boosted Trees, d. = Linear Regression, e. = Nearest Neighbours.
Source: Authors.

The Probability Density Histogram defines the way of the probability density distribution in the set intervals. From the outputs of the Probability Density Histogram, it is evident that the most successful method is Nearest Neighbours, followed by Neural Network and Gradient Boosted Trees. The middle illustration in each line shows the training data set residue histogram. It is ideal when the histogram takes on the form of the Gaussian curve. This goal is reached in all cases apart from Linear Regression. So far, however, all models were assessed only based on the characteristics of the training data set, i.e., on the data set serving for the creation of the models. However, the actual state is presented by the graph of testing data set residues. It provides the space for validation of the results of the models. The best results were reached by the Neural Network residues. These range approximately in the interval [-100, 100]. On the imaginary second rank, there is the model created using the Gradient Boosted Trees. The values of the testing data residues oscillate in the interval [-150, 150]. Even slightly worse results were reached by the residues of the Nearest Neighbours residues. The basic statistics of the balanced time series and the predictions for individual models are stated in Table 2.

Tab. 2. Basic statistics of the balanced time series and the predictions according to individual models

Method	Minimum	Maximum	Mean	Standard Deviation	Variance
Neural Network	528.762	1,863.17	1,222.25	318.805	101,637
Decision Tree	634.318	1,669.27	1,221.46	307.28	94,421
Gradient Boosted Tree	558.587	1,776.47	1,227.42	313.74	98,432.5
Linear Regression	673.503	1,698.86	1,228.72	262.965	69,150.8
Nearest Neighbours	529.5	1,895	1,221.17	311.539	97,056.6

Source: Authors.

Therefore, the best method must be chosen by an expert assessment of the prediction of the future gold price development. The final predictions of the gold price for the following 12 months are shown in Figure 5.

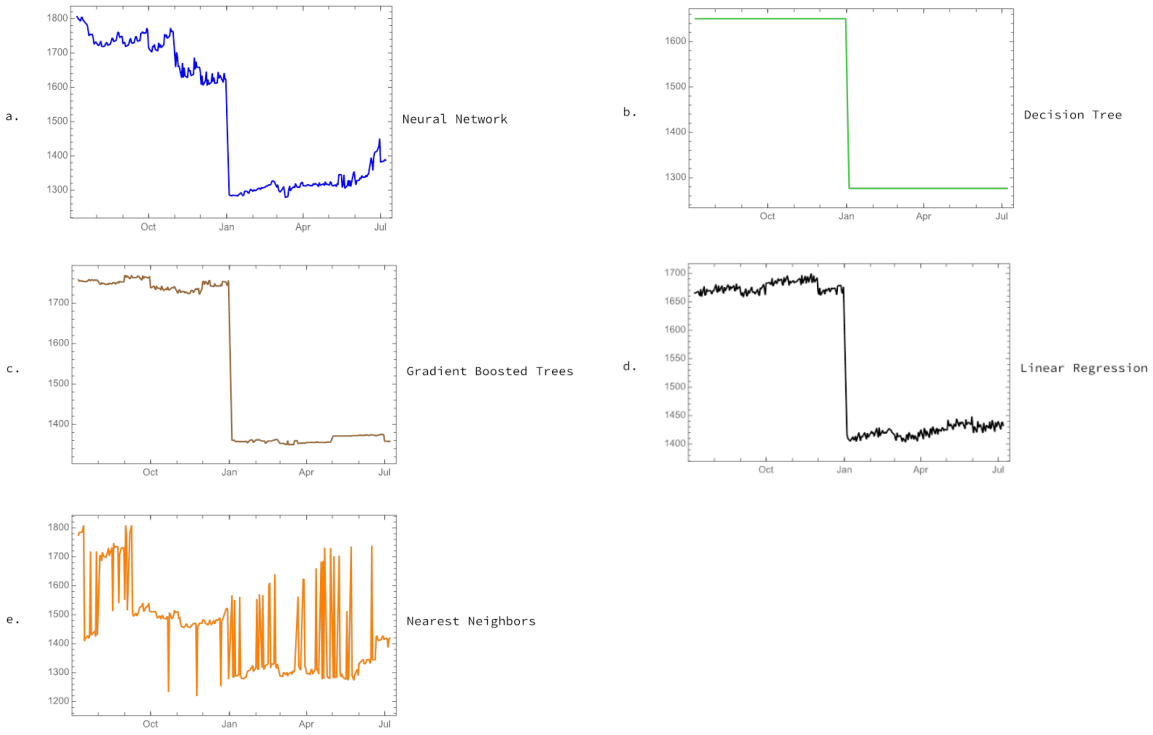

Fig. 5. Prediction of the gold price to 7th July 2021, given in CZK
Source: Authors.

The model created using the method Nearest Neighbours seemed to be the most promising one. However, its values are strongly fluctuating, and the differences between individual business days reach even more than 400 CZK for ounce. In the case of other models, such a fluctuation can be observed as well. There is, however, only one predicted fall at the beginning of the year 2021. For the rest of the time period, rather regular development is predicted. Considering the input values of the prediction (i.e., the last known values of the gold price), the volatility of the time series, and characteristics of the balanced time series, Neural Network seems to prove itself the best method for the gold price prediction in CZK.

Discussion

For the purpose of the analysis, two research questions were determined. The first task was to determine whether the gold price grew even in times of economic recession or crisis. Generally, gold is understood as a preserver of value and a tool of treasuring. Both of these characteristics stem from its physical and chemical qualities and are determined by the preciousness of this metal on Earth (Gutiérrez, Franco and Campuzano, 2013). Therefore, it is logical that economic theories are based on the premise that the demand for gold and, consequently, its price grows at times of economic crises when the value of national currencies decreases (Cohen and Qadan, 2010). Paramita, Vivekananda and Debasmita (2017) state that it is also worth mentioning that, in the past, money existed in many forms. It was present in the form of cattle, specific products (for example, linen scarfs in the 10th century at the Czech territory), later as silver or gold (or coins made of these metals). Given the fact that these metals occur very rarely, they were very valuable (Ismail, Yahya and Shabri, 2009). According to Tully and Lucey (2007), with the world economic boom, however, humankind encountered a lack of money. Therefore, economists looked for new means of payment. Consequently, treasury notes and later banknotes were issued. They were, at first, covered by gold, precious metals, and other possessions. Such coverage came to its final end in the case of American Dollar in the 1960s when the USA withdrew from the so-called Gold standard (E, Ye and Jin, 2019). Nowadays, money is covered mainly by the trust of market participants – state, companies, and households. Moreover, it is exactly this trust or mistrust in the national currency that, in specific cycles of the national economy, increases or decreases the demand for gold that is compact, keeps its value, and makes it possible even to cumulate this value. At the times of an economic crisis, it occasionally happened that states covered their economy's deficits by issuing new banknotes. Given the fact that the economic performance did not increase (rather the other way around), the real value of money decreased. The ones who wanted to save their property and its value had to exchange it from money to a different property. If the investor tries to profit at times of an economic crisis, they buy securities, most preferably stocks. During the crisis, the stock price decreases (Stefko, Jencova and Vasanicova, 2020). In the conditions of the market economy, all business entities, which can be viewed as socio-economic systems, must be competitive (Ginevicius, 2019). The investor can, therefore, buy a relatively large amount of property for a low price. However, there has to be an assumption that the crisis passes in a short period of time, and the stock price increases. However, if the investor cares about preserving the value, they consider rather a purchase of precious metals, mainly gold and gemstones (Mahato and Attar, 2014). Contrary to gemstones, gold preserves its value in its pure form. In the case of gemstones, their value is influenced by their purity or cutting. Gold has, therefore, an exceptional status. Nevertheless, the essential axiom of the economic theory is the rational behavior of the market participants. In practice, however, a number of market participants behave in a different way. The reason is the prevailing uncertainty, lack of information, or different than rational reasons for making a decision (Balagopal and Sanket, 2018).

In the observed time period, we can identify the so-called Great Recession dating back to 2007-2015. It was caused by the financial crisis of the mortgage market in the USA. It hit its full force on a global scale, mainly in 2008-2010 (Fragkogianni, 2016). In 2008, the gold price grew significantly, specifically from 650 CZK to more than 1,000 CZK for ounce. Subsequently, the gold price remained stable on a relatively high level for about a year and then dropped to 700 CZK. In 2009-2012, the gold price increased up to almost 1900 CZK for ounce. Then, it decreased gradually. Its lowest point, approx. 1,000 CZK, was reached in 2016. In 2019 and 2020, the time series grows again. The answer to the research question can, therefore, be summarized in the following way: When the market participants identify the upcoming market crisis, they have the tendency to buy gold. This reflects itself in its growing price. After a relatively short period of time, however, they sell the gold again, and the price stabilizes or even decreases. Such behavior can be caused by two causes:

1. Market participants buy gold at the moment when they have available financial means that can be invested this way. As soon as they realize that the negative expectations predicted in connection with the economic crisis did not come true, they sell the investment gold in order for their investment not to lose its value. In a short period of time of the investment, the market participants can profit from the transaction. Therefore, some subjects might invest in gold at the time of the beginning economic crisis for speculative reasons. Their goal does not necessarily have to be the preservation of the value but its increase.
2. Market participants buy gold even when they do not have enough available financial means for their activities because they fear to lose the value of the national currency. However, due to the fact that they did not have enough financial means at the beginning, they are forced to sell after a relatively short period of time.

The second question draws attention to the future development of the gold price. The prediction of gold price future development is represented in Figure 6.

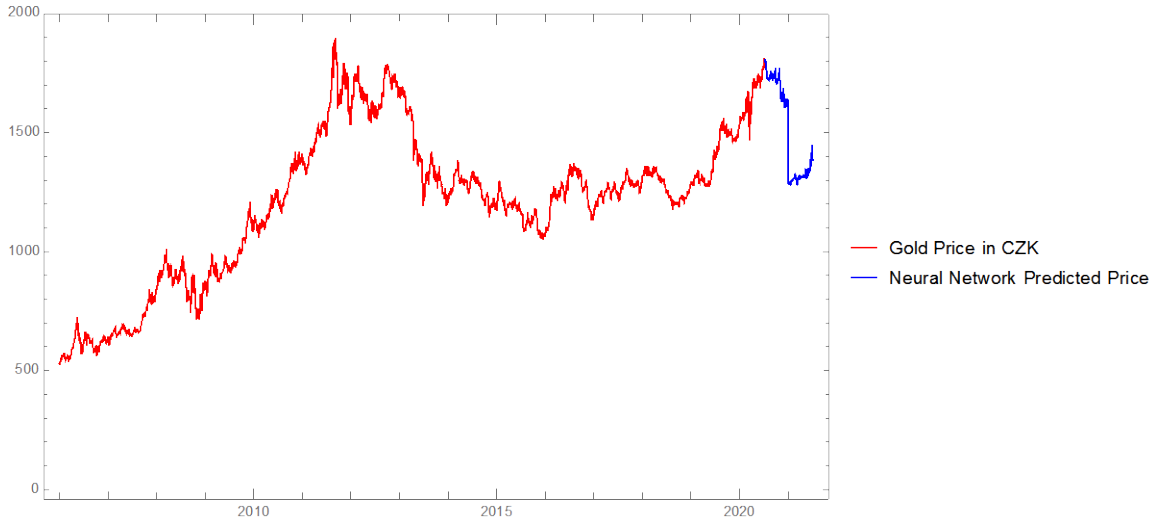

Fig. 6. Future development of the gold price in CZK and prediction of the future development to 7th July 2021
Source: Gold – the current price of gold, investment gold (2020), authors.

The red part of the curve illustrates the past development of the London Fix up to 8th July 2020; the blue part represents the observed variable's prediction to 7th July 2021. The graph shows that the gold price reached its maximum exactly in the observed period. Subsequently, it should decrease progressively to the end of 2020. At the beginning of 2021, the gold price should fall dramatically in order to grow gradually again in the next six months. Is such development probable? The current situation is caused mainly by COVID-19 precautions and introduced sanctions in the sector of international trade. A number of countries adopted measures against the COVID-19 pandemics. These cost an enormous amount of financial means as they did not include only epidemiological precautions. The governments tried to prevent economic bankrupts and slump in the standard of living. Market participants were heavily subsidized by the state, although they did not produce any value. This caused the deficit of the national economy to grow. In the future, countries like the Czech Republic will suffer under the consequences as they have not created financial reserves for such situations. Therefore, it can be expected that the return to some sort of a standard working economy will be gradual. The country will run short of financial means for supporting businesses and inhabitants. An economic recession is, therefore, to be expected. Although the governments do not admit it, the first signs confirming the probability of such a scenario start to emerge (Sukharev, 2020). Market participants now look for the most suitable investment opportunities with the goal of keeping their property on its current value. That is the reason for the increase in the gold price with the introduction of international sanctions. However, according to Corbet, Larkin and Lucey (2020), there are some indications that companies start running out of cash. The gold price will, therefore, rather stagnate first before falling significantly as such a situation is not sustainable in the long run. Companies, trying to secure their operation, will sell gold.

Conclusions

The aim of the paper was to estimate the future development of the gold price. Two research questions were set at the beginning.

Dates in the time period from 3rd January 2006 to 8th July 2020, i.e., 3,663 entries about the gold price, were examined. To elaborate this paper, the software Mathematica from the company Wolfram in its version 13 was employed. Specifically, five methods for balancing the time series and, therefore, obtaining the development model of the observed time series were used – Neural Networks, Decision Tree, Gradient Boosted Tree, Linear Regression, and Nearest Neighbours. Considering the input values of the prediction (i.e., the last known values of the gold price), the volatility of the time series, and characteristics of the balanced time series, Neural Network seems to prove itself the best method for the gold price prediction in CZK. The gold price should decrease progressively to the end of 2020. At the beginning of 2021, the gold price should fall dramatically in order to grow gradually again in the next six months.

It can be concluded that market participants buy gold in the first moments of the economic recession in order to keep the value of their property. Subsequently, however, they lack cash and are forced to sell the gold again. A similar development can be expected now too. Experts expect a global economic recession. For this reason, companies and households purchased gold. Its price increased. Now, however, they encounter problems connected with their liquidity and do not dispose of cash. This state is sustainable to the end of the year. This will put the debtors under pressure, and they will be forced to get rid of their investments. This will cause a dramatic fall in the gold price. In a couple of the following months, the gold price will increase only minimally.

The aim of the paper was fulfilled.

The next development of the gold price is based on the presupposition of a coming economic recession. An interesting topic for further research would be the examination in the field of substitute goods, i.e., investments serving for preserving the value of the property or alternatively of an investment portfolio (in this case, the portfolio does not have to serve only for preserving the value but also for its potential growth).

The limitation of the contribution may be the expression of the gold price in CZK. However, it is the currency of a small economy that has experienced the monetary intervention of the central bank. It would be appropriate to repeat the research also with input data in USD units. Further research should aim at comparing actual and predicted gold price development. This will determine the real success of the methods and predictions.

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