

Gold and Bitcoin Prices Trend Forecast Based on Arima and Grey Prediction

Xiangye Zhu^{1,*}, Zitong Wang², Hao Liu¹ and Jing Wang³

¹School of Electrical Engineering and Automation, Wuhan University, Wuhan, China

²Computer School of Wuhan University, Wuhan, China

³Faculty of Artificial Intelligence in Education, Central China Normal University, Wuhan, China

*Corresponding author: vj162774@163.com

Abstract. This paper aims to study the investment strategy of gold and bitcoin markets and look for a better solution in the investment market to obtain more profits. We first analyze and forecast the gold and bitcoin markets by establishing several models, and find out the model that can best fit gold and bitcoin. Then, based on the optimal models, the most appropriate investment algorithm is proposed to help investors make decisions on every day's investment in order to reap the greatest rewards.

Keywords: Grey Forecast Model; Arima Model; BP Neural Network; Strategy Algorithm.

1. Introduction

In the investment industry nowadays, more and more people prefer buy gold or bitcoin for avoiding currency devaluation or reaping greater profits. Mehmet Huseyin Bilgin and his team emphasized in their article [1] that gold has good safe-haven properties which make it a suitable carrier of the deal in the past 2000 years. Institutional investors, individual investors and even central banks of some countries, they all have passions for gold. Bitcoin, by contrast, since its creation in 2008, has become a major cryptocurrency in terms of market capitalization and continues to attract the attention of investors and policymakers [2]. It can replace cross-border transactions and remittances in the foreign exchange market [3]. Besides, it has also been proved to have safe-haven properties [4].

However, most of the current studies on the determinants of Bitcoin returns are of an explanatory nature, focusing on the influence of specific factors on the Bitcoin price, and not on the predictive or classification ability of the models [5]. For example, global factors [6], including stock index, economic policy uncertainty [7], global economic uncertainty [8], gold spot prices, implied volatility and crude oil prices. And most of these studies use VAR and FAVAR models.

As for the models used in existing studies to predict Bitcoin and gold, Classic time-series techniques and some new approaches have been applied for gold price forecasting, while deep learning methods are more common for Bitcoin price prediction. For example, Vidal, A. and Kristjanpoller, W. use a CNN-LSTM approach to forecast gold [9], Makala, D. apply ARIMA and SVM [10]. While Wu, C. H. and others predict Bitcoin's price with LSTM [11], Karasu S. uses machine learning methods [12], Poyser O. applies Bayesian Structural Time Series [13], Atsalakis G. S. and others make bitcoin price forecasting with neuro-fuzzy techniques [14]. However, most studies do not guarantee the robustness of their models, nor do they prove the superiority of their methods through practical comparisons.

So after testing, we chose the grey model and the Arima model to predict the price of gold and the price of Bitcoin, respectively. Then we introduce the BP neural network and build a risk factor to prove the correctness of our strategy. The fundamental importance of this research lies in coming up with a comprehensive and optimal decision support tool that combines gold and Bitcoin to help investors gain greater profits. We attach importance not only to the plan itself, but also to the accuracy of the models.

2. Gold prices prediction model

On the basis of the market background, we propose a modeling method for predicting the prices of the bitcoin and gold every day.

2.1 The establishment of gold prices prediction model

Specifically, we will use grey prediction to deal with the volatility of the stock market, so as to find a better buying and selling scheme.

The given data shows the change of assets prices with time, but the time sequence is not continuous and lacks differentiability. Gray prediction model is a forecasting method that builds mathematical models and makes predictions based on a small amount of incomplete information.

Based on the analysis of the operational research knowledge we have learned, it is concluded that in order to predict the prices of the next three days more accurately and more convincingly, it is better to evenly distribute the weight to the last six to ten days. Therefore, we adopt grey prediction to obtain approximate differential equation.

GM (1, 1) model is a first-order differential equation model, and its form is:

$$\frac{dx}{dt} + ax = u \quad (1)$$

The discrete form and prediction formula are as follows:

$$\Delta^{(1)} \left(x^{(1)}(k+1) \right) + a(x(k+1)) = u \quad (2)$$

$$\hat{x}^{(1)}(k+1) = \left[x^{(1)}(1) - \frac{\hat{u}}{\hat{a}} \right] e^{-\hat{a}k} + \frac{\hat{u}}{\hat{a}} \quad (3)$$

According to the definition of derivative, we can transform the formula into the following form:

$$\frac{dx}{dt} = \lim_{\Delta t \rightarrow 0} \frac{x(t+\Delta t) - x(t)}{\Delta t} \quad (4)$$

By using written matrix form and solving differential equations, the following results can be obtained:

$$x^{(1)}(k+1) = \left[x^{(1)}(1) - \frac{\hat{u}}{\hat{a}} \right] e^{-\hat{a}k} + \frac{\hat{u}}{\hat{a}} \quad (5)$$

According to the above steps, we wrote a function grey forecast in MATLAB that can predict the value of the next three days. By calling this function, we can calculate the value of the next three days from the ninth day. The predicted value of gold price is stored in G1, G2 and G3 respectively. The price predictions for bitcoin are stored in B1, B2 and B3. Below are the price forecasts for the next day, based on the previous nine days.

According to the Figure 1 and Figure 2, the grey prediction model for the price of gold has the very good prediction effect, the relative error between predicted and actual values is within 0.04, but it doesn't work so well for bitcoin's price prediction, the relative error is much bigger, so the model can be used to forecast trend in the price of gold, but cannot be used to predict the trend of the bitcoin.

Next, we further verify the accuracy of the model and choose the data of the previous 8 days for prediction, which is shown in Figure 3 and Figure 4.

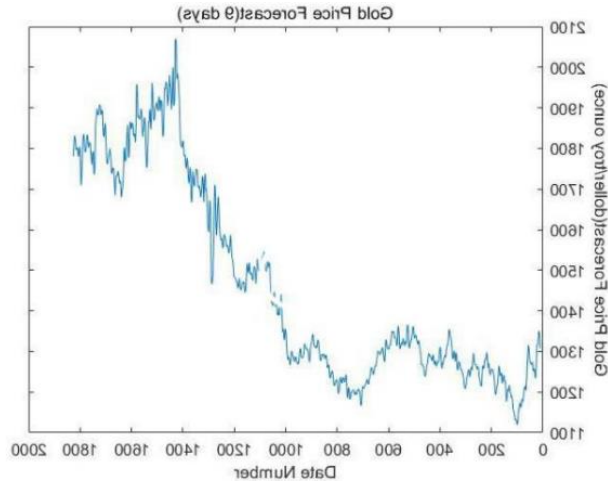


Figure 1. Gold price forecast

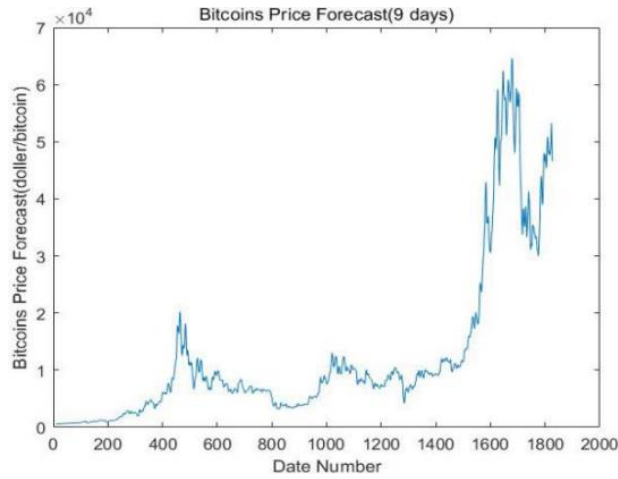


Figure 2. Bitcoin price forecast

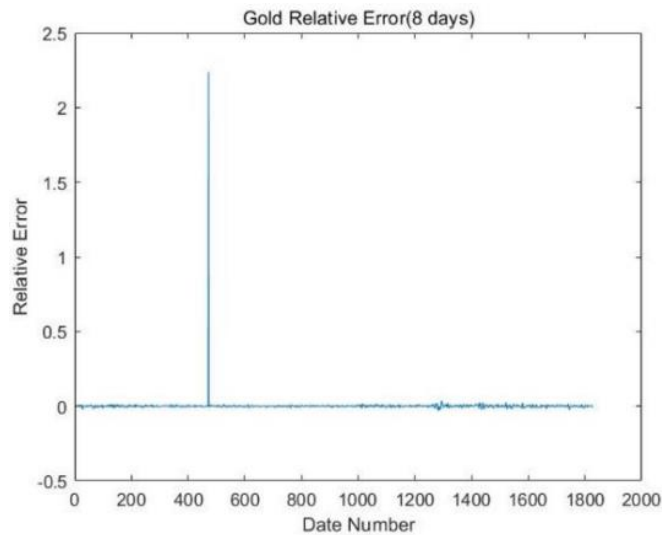


Figure 3. Gold relative error

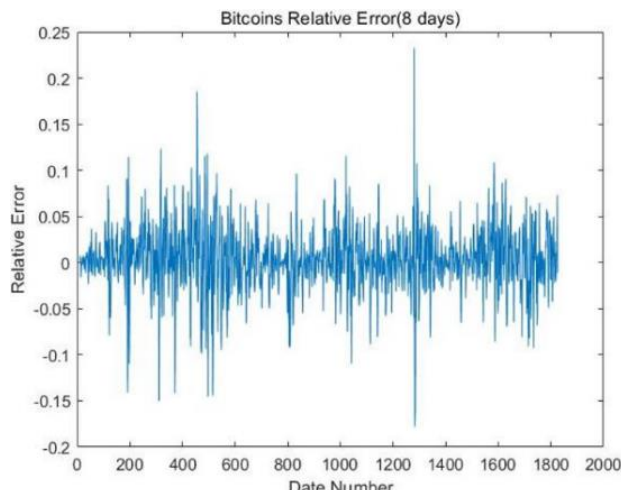


Figure 4. Bitcoin relative error

It can be further verified by the Figure 3 and Figure4 that the model has a larger error in predicting the price trend of bitcoin, so it can only be used to predict the price trend of gold. At the same time, it is obvious that when we choose to use the previous 8 days for prediction. There are interference points. According to our experiment, interference points will appear when the previous days we use is less than 9 days, while the accuracy will decrease when the previous days we use is more than 9 days. Therefore, we use the price data of nine days to predict the price trend of gold.

3. Bitcoin prices prediction model

According to our analysis, the value of gold and bitcoin changes over time and is not fixed, changes of their prices have a strong randomness, there is no seasonal factor in general. Arima models can solve these problems by learning historical data to get a pattern, and then predict the future. Therefore, we try to establish an Arima model to predict the trend of the prices.

We find that the original data can be well converted into a stationary time series if the first difference is taken for the data. Therefore, we take the value of d to be 1. And after removing the outliers, the fitting effect is better when p and q are 0 and 1 respectively by computer software solution. Therefore, the Arima model type obtained is shown in the following formula:

$$\text{ARIMA}(0,1,2) \tag{6}$$

And then ACF graph and PACF image are made, as shown in Figure 5.

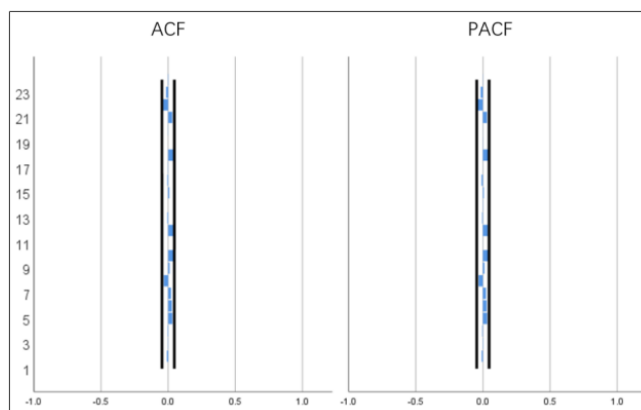


Figure 5. ACF and PACF of bitcoin data sets

As can be seen from Figure 5, there is basically no point significantly different from zero in the figure, indicating that the residual is white noise and the model has well identified the characteristics of time series. In addition, the p value of Ljung-Box test is 0.45, which much higher than 0.05, indicating that the original hypothesis is consistent and the residual is white noise.

Figure 6 below shows our image of Bitcoin prices prediction model, from which it is clear to observe that our model fits the change trend of prices of bitcoin well and makes predictions from day 1826 to day 1850.



Figure 6. Image of bitcoin prices prediction model

By using Arima model to predict the currency, we achieve fairly good results, but when we use a similar approach to modeling the gold prices, only to find that the model is not fitting well our data, for example, we selected the relatively optimal parameters fitting, the parameters are shown in the following formula:

$$\text{ARIMA}(0,1,2) \tag{7}$$

In this model, by making ACF and PACF images, we can find that there are many points that are significantly different from zero, so this model cannot fit the data well and rejects them original hypothesis. The images of ACF and PACF are shown in Figure 7.

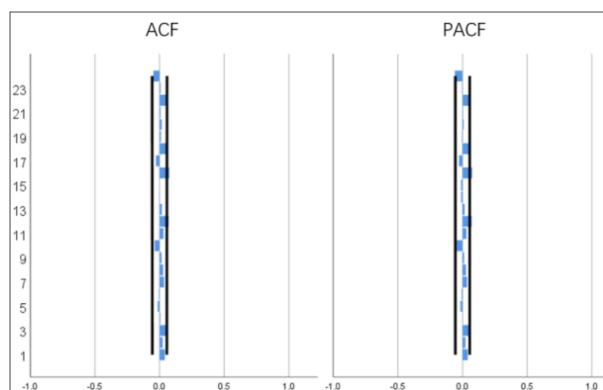


Figure 7. ACF and PACF of gold data sets

In addition, it can be seen from the final prediction result that the data is not well predicted and the fitting degree is not high. The prediction result finally presents a straight line, which is not accurate enough. Therefore, the conjecture of using Arima model to predict the gold price is abandoned, and the Figure 8 of the prediction result is shown below.

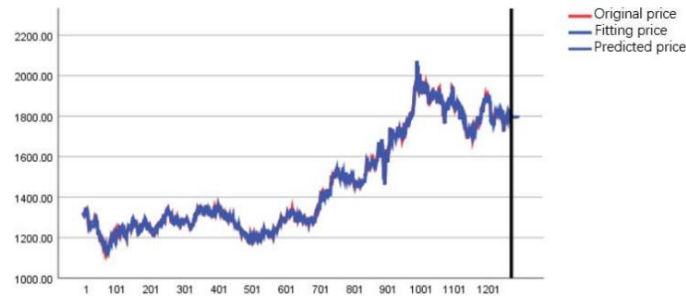


Figure 8. Image of gold prices prediction model

4. Analysis on the prediction and strategy

The goal of market investors is to maximize profits, in other words, they aim to ensure the continuous appreciation of their assets. But every purchase and sale come with a transaction cost. Therefore, it's important to make an accurate and efficient investment. In this paper, we forecast the changes of bitcoin and gold prices, and adopt the optimal strategy to invest in order to maximize the benefits.

4.1 Grey forecasting model

Gray prediction model is mainly to process a small amount of data for accurate prediction. Its core is to build GM (1, 1) model and solve differential equations through cumulative generation, so as to predict the data in the next few days. After establishing the model and solving it, we find that gold has a high accuracy, which can reduce the relative error to a fairly small extent, and the prediction result is relatively accurate. However, bitcoin has a large fluctuation, so we only use it to predict the price trend of gold.

4.2 ARIMO model

According to our strategy, our operation will lead to a stage that we only have one kind of assets every day. In addition, no matter what kind of assets held in the day, there are only three kinds of operation (hold current assets, convert all the assets to the other assets), our strategy is that we choose the operation which will make more profit the next day. In our strategy, each transaction will be traded in full amount to ensure that we on own one type of asset at the same time. This enables our algorithm to deal with it efficiently and maximizes profits when we choose the most profitable path.

The Figure 9 below shows that the prices of gold and bitcoin are always in constant change, in which bitcoin price changes significantly. Our model makes maximum profit by controlling the condition of the deal, even if a fall in the serious situation, it can react quickly to minimize, or even stop losses. This can ensure their assets to maximize.

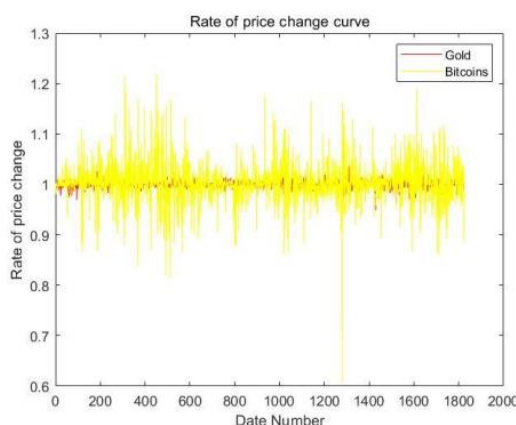


Figure 9. Rate of price change curve

The accuracy of the prediction of future results directly affects the maximum profit we can obtain in the end. In order to prove that the accuracy of our model is optimal, we introduce a new model -- BP Neural network prediction model, and we use Neural Net Fitting in MATLAB for prediction. We select the data of the first 20 days as the basis for prediction, and get the results after training, verification and testing. We make error analysis of the results and get the Figure 10 and Figure 11.

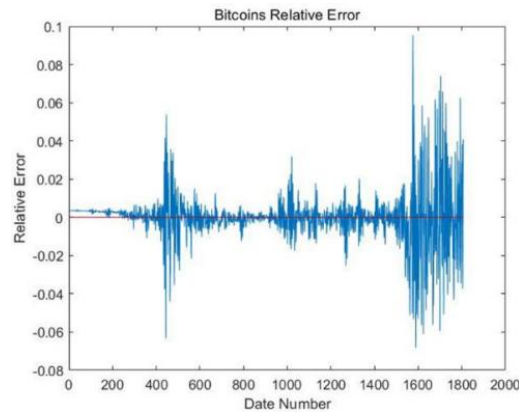


Figure 10. Bitcoin relative error

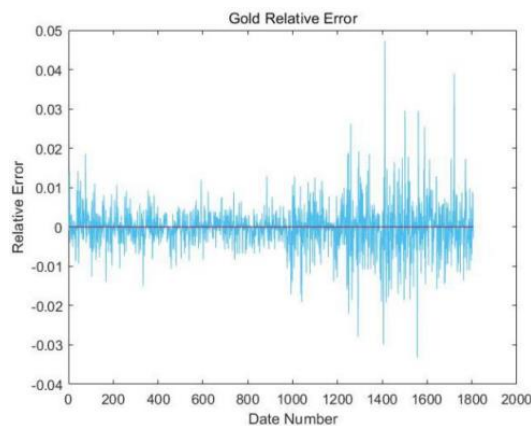


Figure 11. Gold relative error

In order to represent the risk that you might be exposed to when investing in bitcoin or gold, we decided to construct a risk factor. It is represented by the standard deviation of the prediction model. We select the actual data of the first nine days and the predicted data of the next day to solve the standard deviation, and the results are shown in Figure 12 and Figure 13.

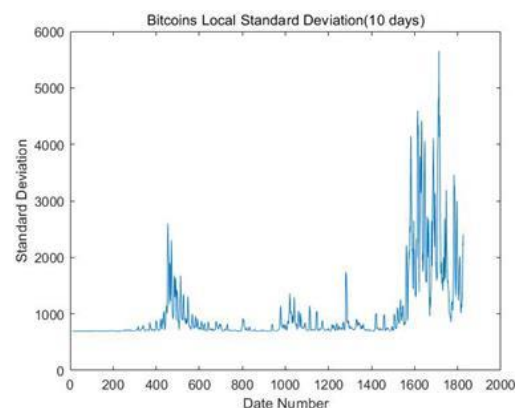


Figure 12. Bitcoin local standard

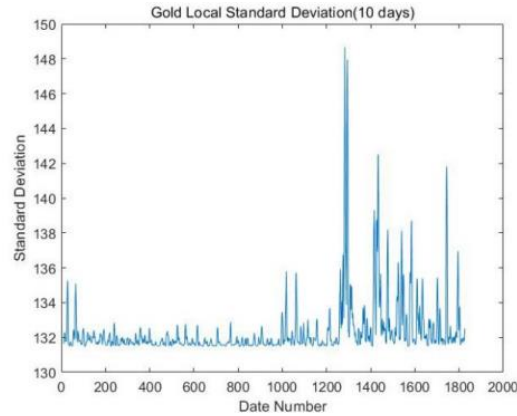


Figure 13. Gold local standard deviation

When evaluating the model, the total assets owned on the last day (in dollars) can be used as an approximate representation of the final return. To test how the values of α_{gold} and $\alpha_{bitcoin}$ would affect our model and the final total value, we set α_{gold} and $\alpha_{bitcoin}$ as two strings of variable values, and let them vary from 0 to 0.06 and 0 to 0.12 respectively. Every set of α_{gold} and $\alpha_{bitcoin}$ values, after investing with our model, will get a final total assets, we draw them into a three-dimensional surface diagram as the Figure 14 and Figure 15.

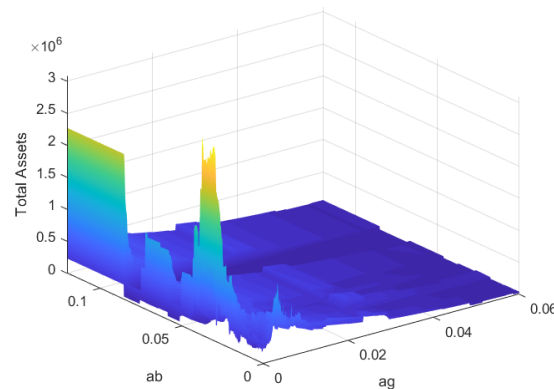


Figure 14. Sensibility analysis ($0 < \alpha_{bitcoin} < 0.12$, $0 < \alpha_{gold} < 0.06$)

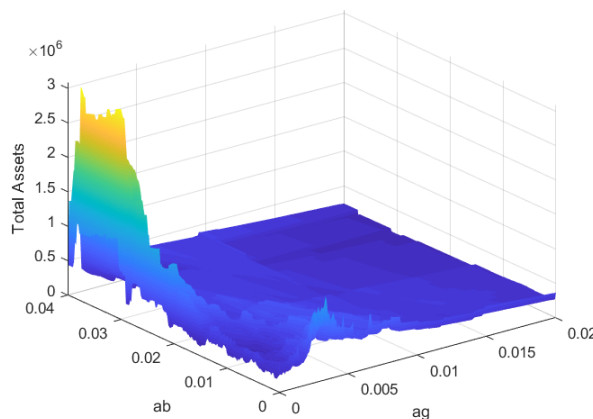


Figure 15. Sensibility analysis ($0 < \alpha_{bitcoin} < 0.04$, $0 < \alpha_{gold} < 0.02$)

5. Conclusion

In this paper, we use two methods to forecast the prices of the two assets, which are as follow: gray prediction model Arima model, by selecting the best method of these two methods, we can obtain our prediction models, according to their data fitting results, we decide to use gray prediction to

predict the gold market trend, and use Arima model to predict bitcoin. Our model has good stability and is suitable for investment in various situations, which ensures the maximization of interests.

References

- [1] Bilgin, M. H., Gozgor, G., Lau, C. K. M., and Sheng, X.. The effects of uncertainty measures on the price of gold. *International Review of Financial Analysis*, 2018, 58, 1-7.
- [2] Al-Yahyaee, K. H., Rehman, M. U., Mensi, W., and Al-Jarrah, I. M. W. Can uncertainty indices predict bitcoin prices? A revisited analysis using partial and multivariate wavelet approaches. *The North American Journal of Economics and Finance*, 2019, 49, 47-56.
- [3] Kim, T. On the transaction cost of bitcoin. *Finance Research Letters*, 2019, 23, 300-305.
- [4] Selmi, R., Mensi, W., Hammoudeh, S., and Bouoiyour, J.. Is Bitcoin a hedge, a safe haven or a diversifier for oil price movements? A comparison with gold. *Energy Economics*, 2018, 74, 787-801.
- [5] Atsalakis, G. S., Atsalaki, I. G., Pasiouras, F., and Zopounidis, C.. Bitcoin price forecasting with neuro-fuzzy techniques. *European Journal of Operational Research*, 2019, 276(2), 770-780.
- [6] Das, D., and Kannadhasan, M.. Do global factors impact bitcoin prices? Evidence from wavelet approach. *Journal of Economic Research*, 2018, 23(3), 227-264.
- [7] Demir, E., Gozgor, G., Lau, C. K. M., and Vigne, S. A.. Does economic policy uncertainty predict the bitcoin returns? An empirical investigation. *Finance Research Letters*, 2018, 26, 145-149.
- [8] Fang, L., Bouri, E., Gupta, R., and Roubaud, D.. Does global economic uncertainty matter for the volatility and hedging effectiveness of Bitcoin? *International Review of Financial Analysis*, 2019, 61, 29-36.
- [9] Vidal, A., and Kristjanpoller, W.. Gold volatility prediction using a CNN-LSTM approach. *Expert Systems with Applications*, 2020, 157, 113481.
- [10] Makala, D., and Li, Z.. Prediction of gold price with ARIMA and SVM. In *Journal of Physics: Conference Series*, 2021.
- [11] Wu, C. H., Lu, C. C., Ma, Y. F., and Lu, R. S. A new forecasting framework for bitcoin price with LSTM. In *2018 IEEE International Conference on Data Mining Workshops (ICDMW) 2018*, 168-175.
- [12] Karasu, S., Altan, A., Saraç, Z., and Hacıoğlu, R.. Prediction of bitcoin prices with machine learning methods using time series data. In *2018 26th signal processing and communications applications conference (SIU)* , 2018, 1-4.
- [13] Poyser, O.. Exploring the determinants of Bitcoin's price: an application of bayesian structural time series. *arXiv preprint arXiv:1706.01437*.
- [14] Atsalakis, G. S., Atsalaki, I. G., Pasiouras, F., and Zopounidis, C. Bitcoin price forecasting with neuro-fuzzy techniques. *European Journal of Operational Research*, 2019, 276(2), 770-780.