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Nature and financial performance of Bitcoin:

Implementing LSTM machine learning for price prediction

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Abstract

Bitcoin has become a popular topic in the recent years. A vast number of researches have been focused on it from multifaced point of views. Economists tried to investigate about the nature of bitcoin and financial performance. On the other hand, data scientists tried to predict future bitcoin price by means of forecasting techniques. In this paper, the previous works on the nature of bitcoin and money, the role of central bank in relation to bitcoin, the impact of news and social media attention on bitcoin price and volatility, the role of bitcoin price increase on monetary aggregates into the economic system in Indonesia case, and the prediction methods implementation for bitcoin price forecasting have been presented. The nature of bitcoin and money are investigated to determine whether bitcoin can be considered as a currency or an asset class instead of alternative of payment means, and according to our discussion presented, Bitcoin cannot be considered completely as a currency, because of the three characteristics, medium of exchange, store of value, and unit of account, that are discussed in the paper.

In our consideration, the implicit nature of Bitcoin with a fixed supply and an increasing demand making it a perfect hedge for inflation. The relation of oil, gold, and bitcoin price at the time of turmoil are discussed to understand which is the most reliable asset in periods of uncertainty. According to previous researches and our investigations, the price of gold and oil, and also the price of oil and bitcoin are negatively correlated in the long run time frame.

We also discussed about the reasons of price increasing of bitcoin in the recent years and the covid-19 role in bitcoin price. A LSTM model is built to predict the price of bitcoin in the future. According to our forecast, the trend of bitcoin price would be downward in the 30 days ahead.

Keywords: Bitcoin price, Bitcoin nature, Long Short Term Memory (LSTM)

Introduction

Bitcoin is a cryptocurrency, which is a digital asset designed to function as a means of exchange that is created and managed using encryption rather than relying on central authorities. The technology behind the many cryptocurrencies, like bitcoin, is blockchain. Blockchain is a peer-to-peer decentralized distributed ledger system that makes any digital asset's records transparent and unchangeable while avoiding the use of a third-party middleman. It is a new and revolutionary technology that is gaining a lot of attention because of its ability to eliminate

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risks and frauds on a large scale. Bitcoin has been widely considered as an investment asset in recent years, after the boom and bust of cryptocurrency prices.

In this regard, several studies have been conducted from multiple perspectives. Schilling and Uhlig [1] proposed a simple model with two currencies presented in the economic system: dollars and bitcoins. They emphasized on that it is important to think on the nature of bitcoin if they can be considered like an alternative payment method or considering bitcoin as a means of investment. The assumption on the nature of bitcoin could affect on macroeconomics variables like inflation. The real value of dollars is controlled by the central Bank while bitcoin supply is decentralized. They stated the analyse of impact of Bitcoin on monetary policy in two scenarios. First, Bitcoin price is independent from central bank policy, but dollar quantity can be pinned down through central's bank policy to maintain price stability. On the other hand, in the "unconventional approach" the Bitcoin price is driven by the central bank's policy. Bitcoin price realizations becomes more likely, as the central bank increase the dollar quantity. Second, the nature of Bitcoin contrasts with the traditional fiat currency issued by the Central Bank, even other private intermediaries can offer money, but they must be regulated. Bitcoin on the other hand is decentralized and the amount of bitcoin available in the system is limited to the capacity to solve mining algorithms by the economics agents.

Some recent studies aimed to consider the impact of news and social media on price of bitcoin. Philippas et al [2] presented that according to their findings, Bitcoin prices are influenced in part by social media attention, implying a sentimental desire for information demand. Lyocsa et al [3] discussed about the impact of bitcoin regulation news, the hacking of bitcoin exchanges and scheduled macroeconomic news announcements on the price of Bitcoin and volatility of it that is measured by realized variance and its jump component. Based on their findings, realized variance and its jump component have comparable characteristics and react to different types of news in the same way. Bitcoin volatility is influenced by news about bitcoin regulation, favorable investor attitude about bitcoin regulation gleaned from Google searches, and, most importantly, hacking attempts on cryptocurrency exchanges. They also found out that the most scheduled US macroeconomic news items, such as government budget deficits, inflation, and even monetary policy pronouncements, have little impact on bitcoin volatility. On the contrary, the hacking attacks had significant impact on the upper conditional distribution of bitcoin volatility.

Several works have done to predict the price of bitcoin. Guidici and Abuhashish [4] tried to know how cryptocurrency prices fluctuate over time, and more particularly, how price information is passed between multiple crypto market exchanges and traditional markets. For this reason, an extended Vector Autoregressive model is proposed. According to their results, the suggested model can accurately capture the significant correlation structure bitcoin prices in various exchange markets, although the correlation between bitcoin prices and traditional assets is modest. Gupta and Nain [5] have considered various features that can contribute to predict bitcoin price by several techniques and compare the results of each algorithm. Chen et al [6] implemented several machine learning methods for bitcoin prediction, and they found Logistic Regression and Linear Discriminant Analysis have outperformed other complex machine learning algorithms.

In this project, the nature of bitcoin and its impact to inflation are theoretically discussed. It is also presented that whether bitcoin can be considered as a currency or an asset class. The role

of bitcoin in monetary aggregates are discussed by considering previous study in Indonesia case. The price of gold, oil, and bitcoin in the long run are compared and the movement price at the time of turmoil is argued. The reasons of bitcoin price increase at the time of covid-19 pandemics are discussed. A LSTM machine learning model is implemented for price forecasting and the results are presented.

Nature of bitcoin and its impact on inflation

The neutrality of money implies that changes in monetary policy in the medium and long run in terms of interest rates and money supply does not affect output, but it affects inflation.

What is interesting to investigate is the role of cryptocurrencies in determining inflation into the economic system and with the related consequences on the monetary policy of a country. The literature regarding cryptocurrencies has exploded and many aspects have been investigated: the role of Bitcoin as a mean of payment alternative to fiat currencies, the role of Bitcoin in illegal activities and the role of bitcoin in speculative bubbles. There are several studies aimed to measure whether there is any relationship between macroeconomics indexes and bitcoin. Narayan et al [7] analysed the relation between the Bitcoin price growth and Indonesia inflation, real exchange rate and money velocity[3]. They tried to demonstrate bitcoin price growth causes inflation, currency appreciation and reduction in money velocity. The role of cryptocurrency is getting more relevant with an increasing market capitalization estimated in billions of USD at the time the paper was written. They aimed from one side to investigate the relation between growth in prices of the cryptocurrencies and macroeconomics variables, and the other side to study central bank policies. The authors take in consideration a dataset of economics monthly data from 2011 to 2018 fitting a GARCH model that demonstrate an empirical association of the increase in Bitcoin prices and of monetary aggregates (inflation, exchange rate and velocity of money). This last evidence has an impact on monetary policy and is very important because inflation is directly correlated to economic growth. The exchange rate is at the basis of the monetary policy. The velocity of money, if it is low, could be a contributing cause of inflation as well. The paper concludes that the unregulated rising of market capitalization of cryptocurrencies could have a destabilizing effect on the monetary system.

Cryptocurrencies are gaining a huge importance in terms of popularity. Even referring the money aggregates Currency M1 M2 M3 like in Canada's example, the market capitalization of bitcoin has surpassed M1. Bitcoin, as the main representative of the cryptocurrencies, is reflected in terms of capitalization of about 1.073 trillion of dollars.

By analysing the nature of bitcoin in relation to the money definition, is it possible to consider it as a currency? The nature of money is investigated through three characteristics, medium of exchange, store of value, and unit of account. It worth to verify whether these characteristics corresponds to the nature of Bitcoin or not. In relation to medium of exchange the nature of Bitcoin is twofold. It can be considered as a means of payment, with limited diffusion, but even more as an investment asset. In relation to store of value, it is true that the value of bitcoin in the recent years has soared, but it is even true that it has experienced a lot of volatility. About unit of account, the values of goods are generally expressed in fiat currency with limited bitcoin

[3] Volacity of money refers to a measure of the number of times that the average unit of currency is used to purchase goods and services within a given time period.

transaction capacity. Although Bitcoin has gained popularity at the time being, it seems that it cannot be yet considered as a full alternative of payment method instead of money, since the nature of the two are somehow not the same.

Does bitcoin have a potential hedge for inflation? Blau et al [8] have taken in consideration the bitcoin price and the Federal reserve bank of Saint Louis five year forward inflation expectation rates. They have demonstrated that changes in bitcoin prices cause changes in the forward inflation rate but not the opposite direction. Like for the paper of "Bitcoin price growth and Indonesia's monetary system" even this paper seems to confirm the relation between bitcoin price and demonstrates a Granger causality with the forward inflation rate. The conclusion tends to propose the bitcoin as a hedge inflation for investment managers.

Can the bitcoin be considered a haven in case of turmoil like gold?

Gold by tradition is considered a haven when there is a political or financial crisis. Significant movements in oil prices are generally associated to political or economic uncertainties. Analysing the correlation between oil prices and prices of gold or bitcoin can help us demonstrate the validity to consider gold or bitcoin as asset haven in turmoil periods. The study conducted by Selmi et al [9] takes in consideration data from 13 September 2011 to 29 august 2017 they show that the oil price and gold, and also bitcoin price and oil price are inversely correlated, as shown in figure 1.

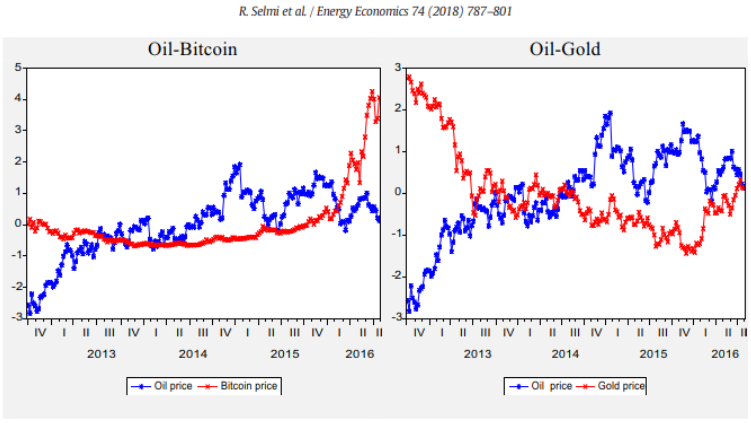
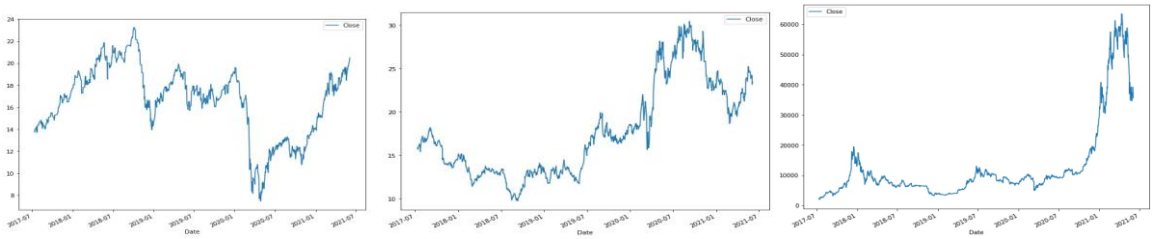


Fig. 1. Daily price dynamics for oil-Bitcoin prices, and oil gold prices.

According to figure 2, we can see that the correlation remained the same also in the time frame after 2016. When covid-19 happened, the oil price dropped and bitcoin price and gold price increased significantly.



(a) (b) (c)

Figure2. oil price (a), gold price(b), bitcoin price(c)

Bouri et al [8] shows that in global uncertainties bitcoin is an asset class that can act as an hedge on inflation. The study then demonstrates a Grange causality. A causality of a reduced risk in

terms of uncertainties for a portfolio containing assets like oil, gold and bitcoin in respect to a portfolio just composed by oil.

If we want to actualize the economic scenario until the current year, we have experienced an injection of trillions of dollars into the US economy followed by similar programs from the main economical areas as a recovery political economy for the covid-19 crisis. Due to low interest rates in many western countries, bitcoin and stock prices soared during the end of 2020, because bitcoin is considered as an asset haven. Also, the possibility to buy stock shares at cheap prices due to the plunge during the covid crisis made them an interesting source for investment. In 2020, the Central Banks have adopted policies to stimulate the economic recovery like in the case of the European Central bank that continues the quantitative easing to keep the interest rates low and with the new Pandemic Purchasing Programme to buy different kind of assets to allow companies and families to receive liquidity. Other policies were focused on increasing the financing capacity of the banks, assure the possibility to access to credit and maintain the financial stability through the international cooperation between the Central banks. In 2020, we observed the availability of huge amount of money directly assigned to companies and to consumers and a general shutdown of the economies, however, companies and consumers did not spend the money at very high rate keeping the velocity of money quite law like the demand with a consequent very low increase of inflation. In 2021 we have seen an increase of inflation; many economists agree of the temporary effect of this surge of inflation as a reaction to the increase of the macroeconomic output. In 2021, in reaction to successful vaccination campaigns, the consequent increase of the demand has made the prices very volatiles.

Model

Because of bitcoin's price extreme volatility, it requires accurate forecasts on which to base investment decisions. Therefore, it is important to build prediction with a method that can predict accurately.

Recurrent Neural Network (RNN) method is useful for designing networks that can recognize on sequence. It is based on the notion of preserving a layer's output and feeding it back to the input to predict the layer's output.

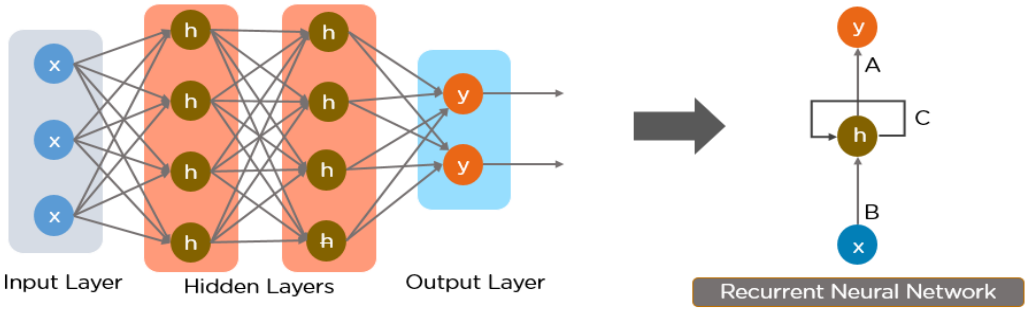


Figure3. RNN Structure

Different layers of the neural network's nodes are compacted to form a single layer of RNNs. The network's parameters are A, B, and C as shown in figure 3.

The default nature of Long Short Term Memory (LSTM), which is the extension type of RNN, is to learn long-term dependencies by remembering information for long periods of time. All

RNNs are made up of a chain of repeated neural network modules. This repeating module in ordinary RNNs will have a relatively simple structure, such as a single tanh layer as it is evident in figure 4.

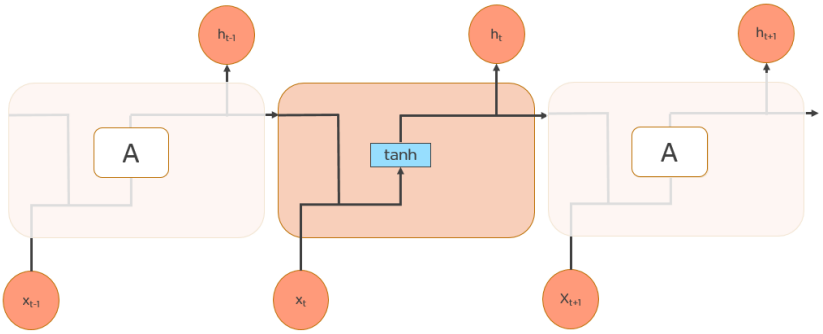


Figure 4. RNN with single tanh layer

Although LSTMs also have a chain-like structure, the repeating module is a bit different structure. According to the figure 5, instead of having a single neural network layer, four interacting layers are communicating extraordinarily.

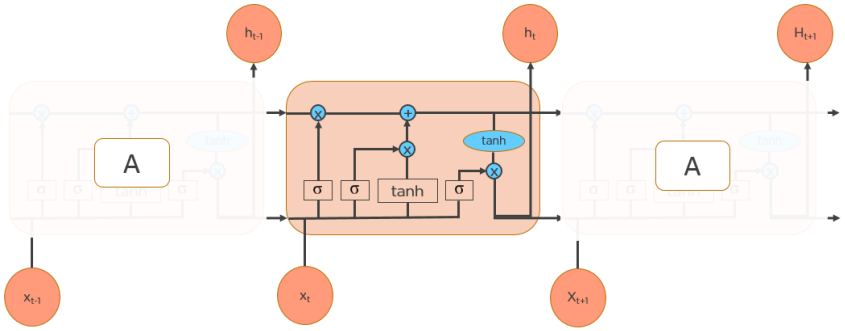


Figure 5. LSTM structure

The long-short term memory cell uses an input, a forget and an output gate. Those gates are illustrated in figure 6, help the network learns what to save, what to forget, what to remember, what to pay attention and what to output. The cell remembers values over arbitrary time intervals, and the three gates regulate the flow of information into and out of the cell. The cell of the model is responsible for keeping track of the dependencies between the elements in the input sequence. The input gate controls the extent to which a new value flows into the cell, the forget gate controls the extent to which a value remains in the cell, and the output gate controls the extent to which the value in the cell is used to compute the output activation of the LSTM unit.

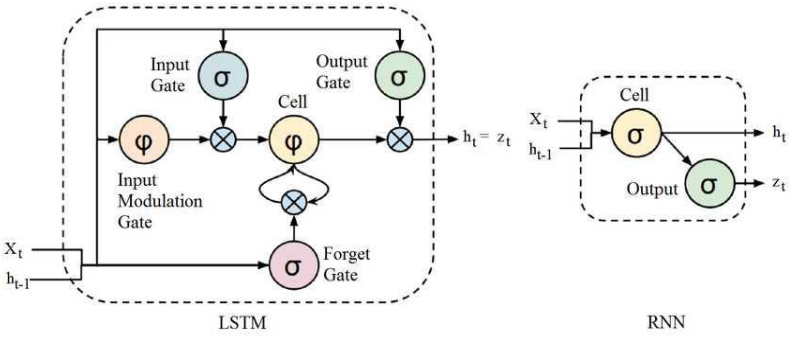


Figure 6. LSTM and RNN structures

In this regard, LSTM is a suitable method for time series data for classifying, processing, and prediction. The reason behind this popularity of the method is that there can be several lags of unknown duration between important events in a time series.

Dataset from the date 2017-07-12 to 2021-06-04 is downloaded from yahoo finance by running the code written below in Python.

```
Start = datetime.datetime(2017, 7, 12)
end = datetime.datetime(2021, 6, 4)
df = data.DataReader("BTC-USD",'yahoo',start,end)
df.head()
```

Date	High	Low	Open	Close	Volume	Adj Close
2017-07-11	2423.709961	2275.139893	2332.770020	2398.840088	1.117410e+09	2398.840088
2017-07-12	2425.219971	2340.830078	2402.699951	2357.899902	8.357700e+08	2357.899902
2017-07-13	2363.250000	2183.219971	2360.590088	2233.340088	8.825030e+08	2233.340088
2017-07-14	2231.139893	1990.410034	2230.120117	1998.859985	9.936080e+08	1998.859985
2017-07-15	2058.770020	1843.030029	1991.979980	1929.819946	1.182870e+09	1929.819946

Table 1. The head of the dataset

The dataset contains seven variables illustrated in table 1. A correlation plot has been built to show the relationship between each variable. It is visible that how this relationship is strong between them. As it is evident in figure 7 correlations are significantly strong between almost all of the variables.

	High	Low	Open	Close	Volume	Adj Close
High	1.000000	0.998307	0.999213	0.999168	0.728109	0.999168
Low	0.998307	1.000000	0.998388	0.999007	0.715592	0.999007
Open	0.999213	0.998388	1.000000	0.998104	0.724733	0.998104
Close	0.999168	0.999007	0.998104	1.000000	0.722657	1.000000
Volume	0.728109	0.715592	0.724733	0.722657	1.000000	0.722657
Adj Close	0.999168	0.999007	0.998104	1.000000	0.722657	1.000000

Figure 7. correlation plot between variables

Bitcoin price has experienced fluctuation during time frame as can be seen in figure 8. However, the overall trend has been increasing. There are several reasons that cause the bitcoin price had risen by April 2021.

First, inflation and the lowering purchasing power amidst massive stimulus spending is driving people to store-of-value assets, including Bitcoin. Since Richard Nixon abolished the gold standard in 1971, the number of circulating dollars has gradually climbed. The overall money supply has expanded from $273.4 billion in 1975 to over $4 trillion as of March 9, 2020, just before the coronavirus arrived. While there are out of work and businesses that have shotted down because of the covid-19 pandemics, the expansion of the money supply has substantial long-term repercussions for the dollar's purchasing power. Many people, understandably, are concerned about much higher inflation rates because of the stimulus expenditure. To hedge against this inflation investors have sought assets that either maintain value or appreciate in value. This hunt for a store of value asset to hedge against inflation has led them to Bitcoin in the year 2020. The reason behinds it is that Bitcoin is the only asset on the planet has a finite and fixed supply. The number of Bitcoins that will ever exist is encoded into the programming. We can be assured of how many there are today and how many there will be in the future.

Second, Bitcoin's mining reward halving mechanism adds to the currency's scarcity and merit as a store of value asset. It is crucial to understand the halving mechanism embedded into Bitcoin's code, if you want to grasp why it has a verified finite quantity limit. The reward provided to miners for processing Bitcoin transactions is lowered in half every 210,000 blocks mined, or approximately every four years. In other words, because a reward of Bitcoin delivered to a miner adds more Bitcoin into circulation, Bitcoin has a synthetic type of inflation built in. Every four years, the rate of inflation is decreased in half, and this will continue until all 21 million Bitcoins are released to the market. Rising inflation and an increase in the amount of the US dollar, depreciates its value over time. Gold has a relatively constant rate of new gold mined from the earth each year, which keeps its rate of inflation fixed. The assets stock-to-flow ratio is increased when each halving occurs with Bitcoin. A stock-to-flow ratio is the ratio of the current stock circulating in the market and the flow of new production. This metric may be charted into the future since the stock-to-flow ratio, or current circulation compared to new supply, doubles every four years. Bitcoin's price has tracked closely with its increasing stock-to-flow ratio, since it has incepted. Each time Bitcoin has been halved, it has experienced a huge bull market[4] that has smashed its previous all-time high.

The third reason is that institutional adoption of Bitcoin and cryptocurrencies as an investment and a service demonstrates a strong belief in the future of the technology. Several public and private institutions have begun amassing Bitcoin rather than holding cash in their treasuries.

In addition, over the last several years, the infrastructure developed around cryptocurrencies and Bitcoin has matured significantly, making investing easier and safer than ever before. Bitcoin has gone a long way since its inception in 2009, from its first primary usage as a mechanism to purchase drugs online to a new monetary medium that guarantees verifiable scarcity and maximum transparency with its immutable record. It is accessible, and the number of places that accept Bitcoin and other cryptocurrencies as payment is rapidly increasing.

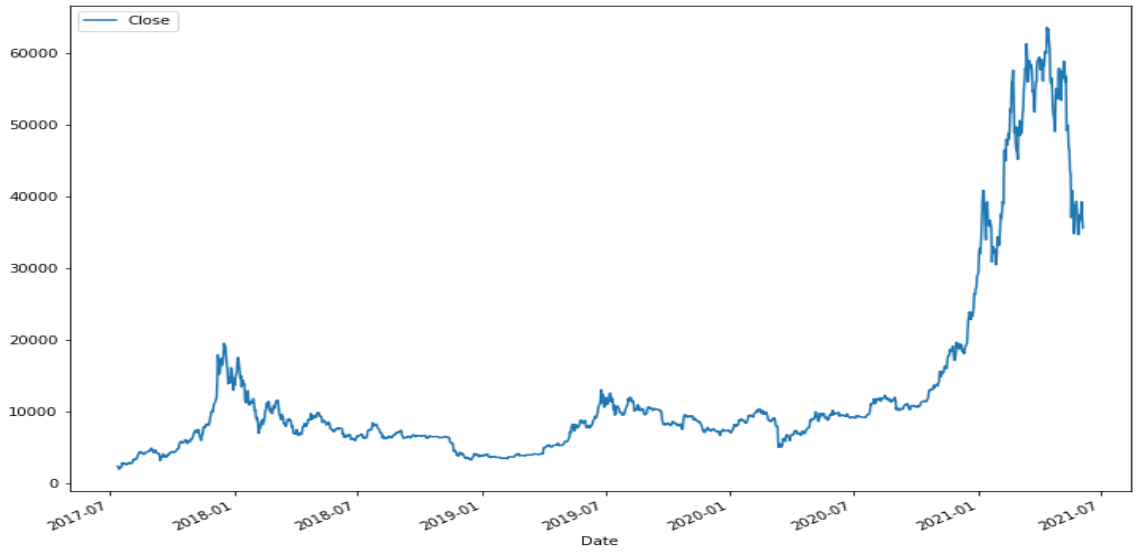


Figure 8. bitcoin price over time

The line graph in figure 9 shows the close price of Bitcoin from 2020-06-04 to 2021-06-04 with orange color. It is evident that the close price of Bitcoin has had fluctuation during times,

[4] It is a term used in financial markets to describe a period of time during which the price of an asset or security continues to grow.

however in overall it grew by the date April 2021, and then it experienced a drop by June 2021. Also, 30 days moving average has been plotted on the graph. By calculating the moving average, the impacts of random, short-term fluctuations on the price of a stock over a specified timeframe are mitigated. It worth to mention that The moving average is a technical analysis indicator that represents the market's average closing price over a given period of time. In general, if the price crosses the moving average from below to up, investors expect that stock price or cryptocurrency price would increase, and vice versa.

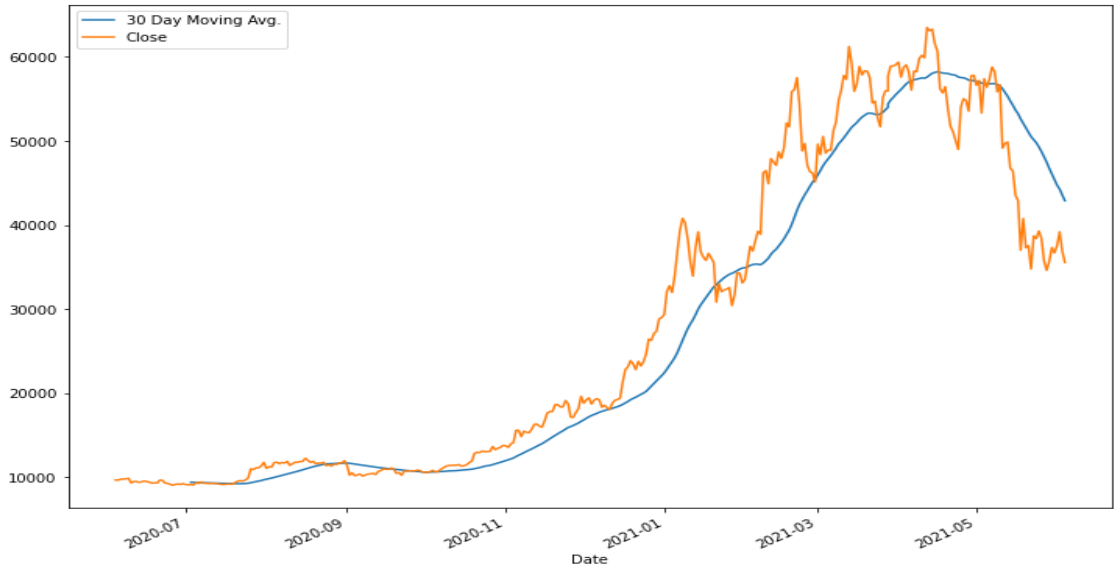


Figure 9. close price of Bitcoin from 2020-06-04 to 2021-06-04

In figure 10, the actual bitcoin price in blue, training data[5] in orange and test data [6] can be seen in green. This plot shows how much the implemented model can predict the bitcoin price. 70 percent of data considered as training dataset and 30 percent of our data considered as test dataset.

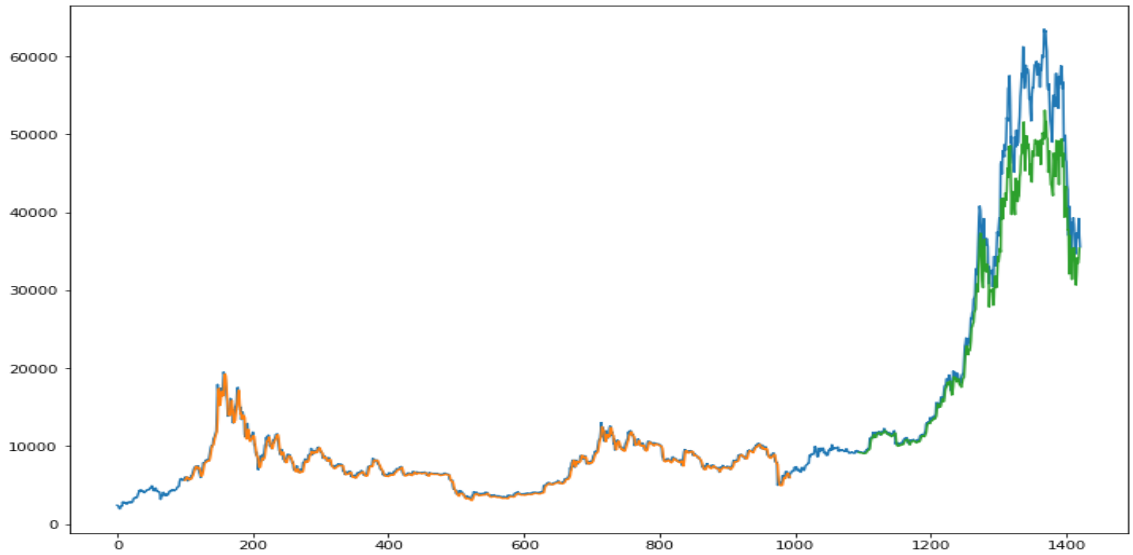


Figure 10. close price, training set, and test set plot

[5] Training data is the data which is used during the learning process and to fit the parameters.
[6] Testing data is the data which is used after the learning process to see how much the fitted parameters and built model are able to predict the test data.

The orange line illustrated in figure 11 shows a forecast of the bitcoin price for the upcoming 30 days ahead. It shows that the bitcoin price will drop until next 30 days, according to our LSTM model.

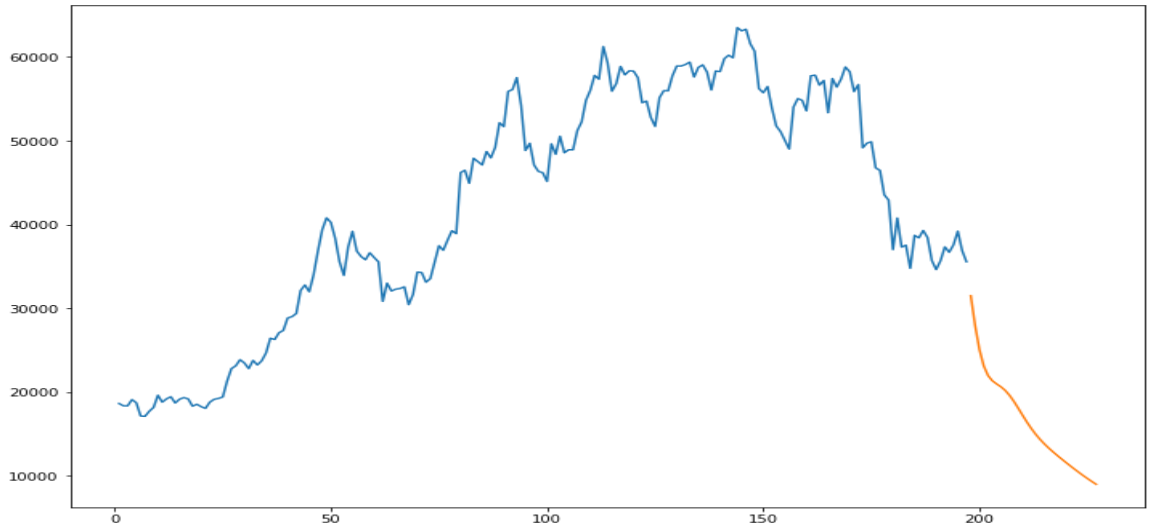


Figure 11. bitcoin price prediction

Conclusion

Bitcoin has been a topic of interest, particularly in the last recent years. A vast number of researches have focused to understand the mechanism and nature of bitcoin in order to find out how the technology behind it works, understanding the movement behavior of it and to measure whether it is profitable to invest on it. On the other hand, many studies have concentrated on the price increase of bitcoin and the reason behind it and the role of bitcoin in turmoil scenarios.

In this paper, bitcoin has been tried to be discussed from multiple perspectives by considering several previous studies done before. The nature of bitcoin and the role of price increase of bitcoin in monetary aggregates are presented to give a better understanding about the mechanism of Bitcoin. The nature of bitcoin and money is investigated in this study to see whether bitcoin can be regarded as a currency or an asset class. Bitcoin cannot be fully classified as a currency due to the three qualities outlined in the paper: medium of exchange, store of value, and unit of account.

The implicit nature of Bitcoin, with a fixed supply and increasing demand, makes it a great inflation hedge in our opinion. The relationship between the price of oil, gold, and bitcoin during times of instability is reviewed in order to understand the behavior movement of the three during times of turmoil.

The price of bitcoin grew in the recent years. The reasons of this significant increase has been discussed and the role of the covid-19 for this grow has been taken into account. A LSTM model is developed to forecast the future price of bitcoin. The price of bitcoin is expected to drop in the next 30 days, according to our forecasting.

For the future works, the consideration of other machine learning models implementation to compare which model performs more accurate is suggested.

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