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### BITCOIN PRICE PREDICTION USING THE (BOX- JENKINS) METHOD

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## ABSTRACT

The research dealt with the study of forecasting bitcoin prices in the short term, and the (Box-Jenkins) method was used because of the advantages of this method. The (Box-Jenkins) methodology has specific criteria and conditions, but the acceptance of the optimal standard model depends on the compatibility of statistical and economic standards.

**Keyword:** *forecasting , Bitcoin , Box-Jenkins*

## INTRODUCTION

Technological progress has played an important role in the development of electronic money and then in the emergence of digital money, which reflected on all economic activities, and the research dealt with the problem of fluctuation in the prices of digital currencies (bitcoin ) as recently witnessed a relative demand, which encouraged individuals and financial institutions to invest in them as a result of high prices .

**The importance of research:** highlighting the concept of digital currencies and the reasons and justifications for their rise in prices globally by studying the prices of bitcoin during the period of time from 2012 - 2020 and the feasibility of predicting the prices of digital currencies .

**Research problem :** the research problem is therefore: digital currencies suffer from severe volatility in the global financial markets, and this is reflected negatively on the performance of investment portfolios of

individuals or financial institutions, so the research came to answer the question : is it possible to adopt the Box-Jenkins method in predicting the prices of bitcoin .

**Research hypothesis:** the research proceeds from the hypothesis that the Box-Jenkins method can be used in the process of economic forecasting of bitcoin prices .

**Research objective:** the objective of the research is to identify modern standard tools to obtain the best models in the economic forecasting process using the Box-Jenkins method.

**Scope of research:** study the fluctuations of bitcoin prices during the study period from 2012-2020 and try to predict their prices during the last four months of 2020 .

**Research method:** the research used standard as well as descriptive methods to study Bitcoin price forecasting.

**Research structure :**

Topic 1: theoretical framework of the digital currency bitcoin

Topic II: theoretical origins of box Jenkins ' methodology in forecasting

Third topic: a standard study to predict bitcoin prices

Topic 1: theoretical framework of the digital currency bitcoin

**FIRST : THE CONCEPT OF DIGITAL CURRENCIES (DEFAULT ) :**

The tracker of the historical development of money through the Times clearly notes the characteristics and features of each stage starting from commodity money stage through paper money, then electronic money and finally digital money, including bitcoin, this is evidence that the development of money points to the compatibility of digital currencies with the era of digital economy .

Studies indicate that it is difficult to define money because of the difference and multiplicity in the functions of money as well as its evolution through time periods, so how do I want to define the concept of digital money ( including bitcoin)? The definitions varied, including the following (swailhi, 2018: 219) :

- An innovative global financial exchange.

- An integrated online payment system called block chain.

- Cryptocurrencies (crpto-currency) have no tangible physical presence.

Bitcoin (Bitcoin) is a digital representation of a monetary value not issued by the central bank (Federal) as it is accepted by natural people as a means of payment or electronic trading, a new form of money, and it has been excavated (issued) through high-speed computer programs on an innovative electronic network, and this currency receives relatively optional acceptance as there is no currency trading Digital (researchers, 2017 : 13-19 ) .

Bitcoin is not a bubble as some think it is in line with the requirements of the era of globalization and economic openness, the bubble (a commodity whose price doubles rapidly and in a relatively short time does not reflect its real value), but bitcoin is an innovative commodity that doubles its price gradually so it is different from the bubble, but they share the desire to invest and Carpenter, 2019 : 32 ) .

Therefore, digital or virtual money (Bitcoin, Bitcoin Cash, Ethereum, etc.) are intangible monetary units in the sense that they have no physical grandparents, and derive their strength from the qualities they enjoy, and determine their market value based on the laws of supply and demand since there is no

monetary authority supervised or responsible for the process of issuing cash (crypto), and digital

## **SECOND: THE THEORY OF DIGITAL MONEY :**

There are many theories that have tried to study the demand for money and the factors influencing it, such as classical and treasure theory, Friedman's theory and the motives of demand for money . It can be said that the Tobin-bomol model mimics the reasons for the emergence of digital money ,since this model can be applied to a wide range of financial assets (cash, deposits, shares and bonds), as developments in the field of information and Communication Technology have reduced the cost of transferring between these assets (Al-Barzanji, 2007: 45), resulting in increased demand for digital money as a result of the lack of an intermediary between customers Soderberg, 2018:57).

The total cost of managing funds is equal to the cost of withdrawals, in addition to the interest given to the funds, and the average amount held as funds over a given period requires effective management and the individual to reduce this cost, by focusing on the level of desired transactions, the nominal interest rate and the cost of conversion from interest accounts on funds transferred (Romer, David (1986):45) ).

## **THIRD : REASONS FOR RISING CRYPTOCURRENCY PRICES**

There are economic factors led to the increased demand for Bitcoin most important following :

1-the need for its uses in international trade transactions as an innovative means of payment the volume of international trade has increased over the past few years significantly as the volume of electronic commerce increased from 4 دولار trillion to 25 trillion in 2016 (researchers, 2017: 14).

2-its multiple uses in the shadow economy, especially illegal economic activities such as money laundering, arms trade and drugs (Al-Zalmi and al-Sarraj, 2010 : 54 ).

3 - invested in speculative operations, especially after the year 2012 as a result of high price and gradually, which led to increase demand for them.

However, the real reasons for the rise in the value of bitcoin are mainly due to the following points : (Essam al-Din, 2014: 65), (Badev, Anton, and Matthew Chen (2014)67):

1. the cost of physical assets represented by high-speed electronic computers .
2. the presence of highly skilled human capital that manages this system .

3-electronic system or encryption systems are advanced and urgently need to update constantly .

4-use electronic programs to counteract hacking or virus risk .

5-the process of mining to issue a new currency for bitcoin requires large amounts of electricity .

6-the limited number of issuing new units of bitcoin, as the announced issuance of (21) million monetary units until 2040 (Charlie Shrem (2019): 56).

7-the presence of a reward system to open new bitcoin systems in different countries of the world .

8-technical and technical procedures in the issuance of new units of bitcoin, which means that it is difficult to increase the money supply for technological reasons (Marek D.&Lukasz j. (2018) :43 ).

From the foregoing, it is clear that the reasons for the increase in demand for digital money over the past few years are due to real

and other market reasons (the presence of supply and demand forces ) .

**FOURTH: CHARACTERISTICS OF DIGITAL MONEY-BITCOIN :**

The digital money tracker clearly notes that it is starting to take the same characteristics as money, which is represented by its relative scarcity and fragility as well as its full liquidity, but its acceptance is relative (optional).

The absence of monetary institutions responsible for monetary issuance makes central banks unrecognized, which gives them the advantage of mystery and makes the financial markets in which they deal unstable, which may lead to uncertainty and thus instability in the prices of digital currencies (Luther&white, 2014 : 33). In order to recognize the characteristics of digital money, including bitcoin, it is necessary to distinguish between digital money (virtual) and electronic money, Table (1) shows the points of difference between them:

*Table (1) points of difference between digital and electronic money*

NO	Digital money-Bitcoin	NO	Electronic money-payment cards
1.	It has no physical or physical presence.	1.	It has a tangible physical presence
2.	It has optional acceptance for its customers	2.	It has general acceptance and recognition
3.	Where to deal with the internet, which means an integrated electronic system for each currency	3.	Where to deal with the network of computers and ATMs for each electronic currency
4.	The issuer is decentralized and unknown	4.	The issuer is known and centralized

5.	It's cash service units that don't have a specific cash stock.	5.	They are known cards and have a specific cash stock
6.	Its market value is not specified are subject to the laws of supply and demand	6.	Its market value is specified according to the requirements of the prepaid cardholder.
7.	They are not subject to geographical boundaries	7.	It has limitations and limitations for geographical areas
8.	Mistakes in the movement of money are not reversible or irreconcilable	8.	Amounts can be reconciled and financial errors addressed
9.	There is no intermediary in dealing. they are subject to peer to peer.	9.	Presence of an intermediary between customers, including banks
10.	Mystery and high confidentiality of customer information	10.	Lack of complete confidentiality of customer information
11.	First appearance in 2009	11.	First appearance in the early 1990s.
12.	Its prices are unstable.	12.	Prices are relatively stable

Source: preparation of researchers-based on: (Hamza, 2011: 64), (Nakamoto: 2019 ,28)

Consequently, bitcoin has become a function of money for the following considerations :

1-it is a means of payment as a result of the low cost of the transfer, as an electronic payment method .

2 - you can use speculative operations as a result of higher prices in the short and medium terms .

3. it is considered as a store of value because of the gradual rise in prices during the past decade .

A means of futures payments as a result of their relative price stability in recent times .

**Topic II: theoretical origins of the box-Jenkins methodology**

First: the concept of forecasting:

Economic Forecasting can be defined as a quantitative estimate of the expected values of future economic variables based on available data and information about the past and the present, so it can be said that the behavior of the phenomenon in the future is only an extension of this phenomenon . Prediction is of two types: point forecasting and Interval Forecasting, the latter of which includes prediction before verification and prediction after verification (Abdelkader, 2005 : 696) . The prediction is accurate if it is based on correct scientific foundations and may be inaccurate if the indicators are not clear. Some economists describe the concept of forecasting by saying that it is a process of

looking ahead to a particular phenomenon in the light of the available information and the variables affecting it, or is a rational attempt to know the changes taking place in the future under a state of uncertainty, as well as to know the nature and behavior of various economic phenomena and

Economic forecasting should study possible assumptions about future events, in which standard tools and methods are used in order to obtain accurate results and information that can be relied upon in administrative and economic decisions, and it is necessary to take into account the dynamic factors affecting the phenomenon, which means obtaining a more accurate and reliable prediction.

The importance of forecasting lies in detecting problems before they occur, identifying new ways in the field of economic development and investment, as well as identifying optimal options and rationalizing the trade-off process in economic, commercial and financial decision-making (Miftah Saleh, 2006 : 11). the importance of Economic Forecasting has been proven in many areas, including planning, monitoring, financial asset management, economic crisis management as well as financial risk management. The most important criteria for economic forecasting according to a group of experts are accuracy, ease of Use and interpretation

(Gujarat, 2015 : 417) there are many models of forecasting, the most important of which are the following (Nasser, 2012: 26) :

1-models that link the behavior of the phenomenon to the time factor such as time series and are used for short-term prediction .

2-models that link the behavior of the phenomenon to specific or independent factors and triggers such as regression method and are used for long-term prediction

3-statistical models are based on probability theory , and non-statistical models are based on inductive analysis .

Here it is necessary to distinguish between two types of prediction by style (Abdelkader, 2005: 696) :

Econometrics Forecasting: based on regression models, finds the relationship between the dependent variable and the independent variable and attempts to explain changes in the dependent variable (phenomenon) .

- Time series Forecasting: depends on past values in finding future values, without providing specific explanations for changes in the phenomenon studied .

Prediction is therefore a fundamental part of standard analysis and in general there are five approved methods for predicting time series : exponential boot method, single

equation regression models, real-time equation models and self-regression vector models as well as Arima integrated moving averages (Gujarat, 2015: 1078).

**Second: establish the box – Jenkins methodology:**

1. box – Jenkins methodology :

Box-Jenkins models (Box-Jen) are important statistical methods in analyzing time series models and are used to represent a particular phenomenon and predict its future values . According to the philosophy of this method, the data speak for themselves, which means that the box - Jn models allow the variable (YT) to interpret itself through the values of the variable (y) and with periods of delay or optimal periods of slow down and no external variables (Gujarat, 2015 : 1079)). This method has many features, the most important of which are the following (Zubaidi, 2012: 10):

- Used in cases of time series of stable and unstable .
- Come in standard models of single variable standard models with multivariate
- It is suitable in the process of forecasting in complex time series by discovering convenient standard models .
- It is characterized by accuracy because the models (Box-Jen) fit with the uses of the

electronic calculator as well as being going through specific scientific stages to predict the future .

2 – practical steps of the box-Jenkins method

There are four main steps to the Box - Jen method and can be explained in the following way :

**First stage: identification :**

It is at this stage that the ranks (p, d,q) representing the optimal period of deceleration in standard models are determined by the self-correlation function (ACF) and the partial self-correlation function (PACF), from which the appropriate standard models for economic phenomena can be identified (kanheer, 2012: 311)

**Second stage: estimation Models :**

After the models are graded, the parameters of the standard models can be estimated as Palati (Khalaf, 2015: 130):

- Self-regression model (AR(P)) :
- Model of moving circles (MA (q)) :
- Self-regression model for moving circles (ARMA (p, q)) :
- Self-regression model for integrated moving circles (ARIMA (P, d, q)) :



**Phase III: Diagnostic testing :**

After the evaluation of the standard models and the determination of its parameters and the level of morale of each parameter comes the stage of testing the standard models and research on the reliability of these models . In other words, before using the standard model in the forecasting process, it is necessary to confirm and verify the statistical and economic validity or efficiency of the standard model .

It should be noted here that the methodology (Box-Jen) relies on the experimental model by relying on some statistical criteria and researching the possibility of making the prediction as little as possible, as well as relying on some indicators that make the standard model more efficient . In this regard, there are many measures that look at the quality of the models (Box-Jen) the most important of these tests are the following (ANI, 2016: 5), (Qasim Aga, Zadeh, 2017 : 92):

- ARIMA (p, d ,q) values should be as low as possible (Mondal, Shit , and Goswami , 2014 : 24 ) .
- Find function of the autocorrelation (ACF) and autocorrelation partial (PACF) buy in the model presented, if located within the boundaries of the confidence interval (95% ) this means that the model provided an

adequate and acceptable statistically (behind, 2012 : 137).

- The low value of AIC and Sc allows to obtain the best standard model according to the optimal slowing period (p ,d, q) .
- The reduction of the value (the average absolute values of errors (MAE), the square of absolute errors (MSE) and the absolute ratio of average errors (MAPE)) means that the prediction errors are minimal and therefore the best standard model is obtained
- There are three basic indicators that can be used to compare the models selected to choose the optimal model and these indicators are (number of moral parameters, selection coefficient R2 and dispersion coefficient index (sigma2)) .

**Stage four: forecasting :**

After the standard model has been graded, its parameters assessed and its suitability tested to represent the time series comes the stage of predicting the values of the variable in the future . As mentioned earlier, the Box-Jen method is more accurate than the rest of the standard models, especially in the short term (Gujarat, 2015: 37), and there are two types of predictions (Gujarat, 2015 : 436):

- Static predictions: actual and decelerating values are used in the standard prediction process .

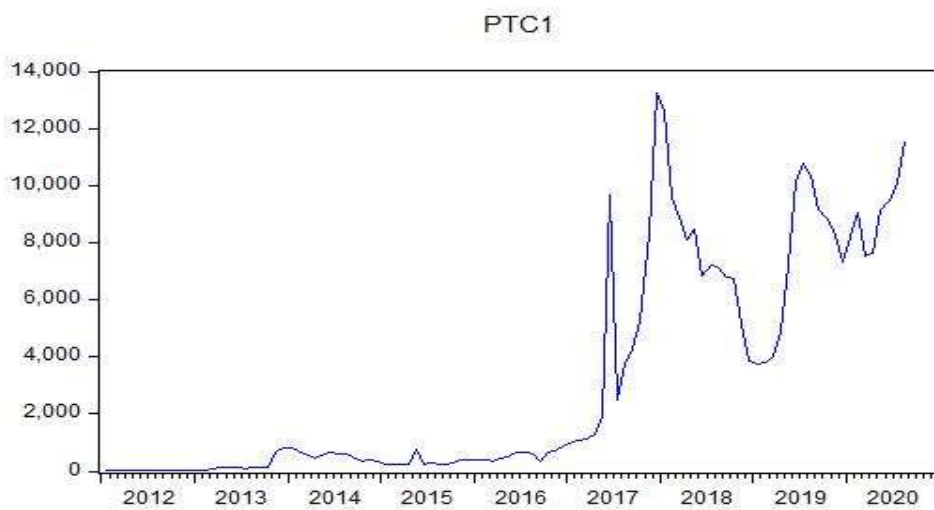
- Dynamic prediction: the prediction of the first period is used in the subsequent prediction process.

**Third topic: a standard study to predict bitcoin prices :**

This research will try to study the prediction of bitcoin prices according to the methodology (Box - Jen) its four stages referred to earlier, represented by the following paragraphs :

First: characterization phase : at this stage the time series of bitcoin prices (ptc1) will be recognized monthly

<https://sa.investing.com/crypto/bitcoin/btc-usd> for the period (2012-2020), we will note that this series will take the general trend as the regular and oscillating movement across the time period takes the case of a trend towards increasing, so the overall trend of the time series is positive despite irregular changes or severe breakdowns such as at the end of 2017, as bitcoin prices fell from 13,242 in December 2017 to 3,869 in January 2018, as shown in Figure 1 .



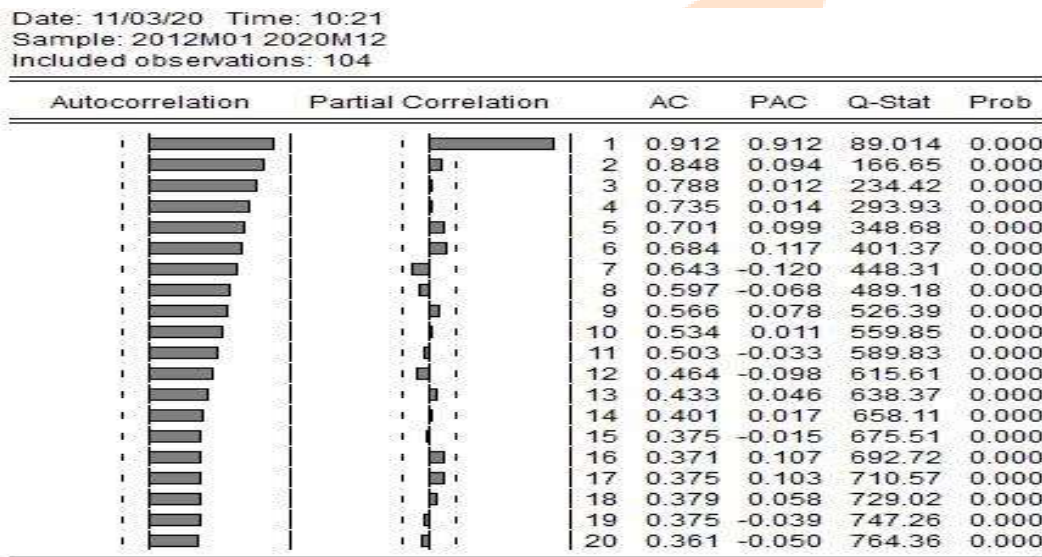
*Figure (1) monthly bitcoin prices for the period (2012 - 2020)*

Since the time series suffers from the state of the general trend, the series is unstable, so the natural logarithm (PTC1) or the first difference can be taken in some standard models for the stability of the time series, as shown in Figure 2 .

In order to find out the rank of the optimal periods of time deceleration (p , D ,q) of the standard models, we estimate the self-correlation function (ACF) and the partial correlation function (PACF), and from Figure 3 it is clear that the self-regression model(AR(p)) of the optimal models in the

estimation process because they are geometrically conceded after one degree of deceleration . Figure (4) shows that the time

series of bitcoin prices stabilized at the first difference, which allows searching in ARIMA models.



Form (3) self-correlation function and partial self-correlation

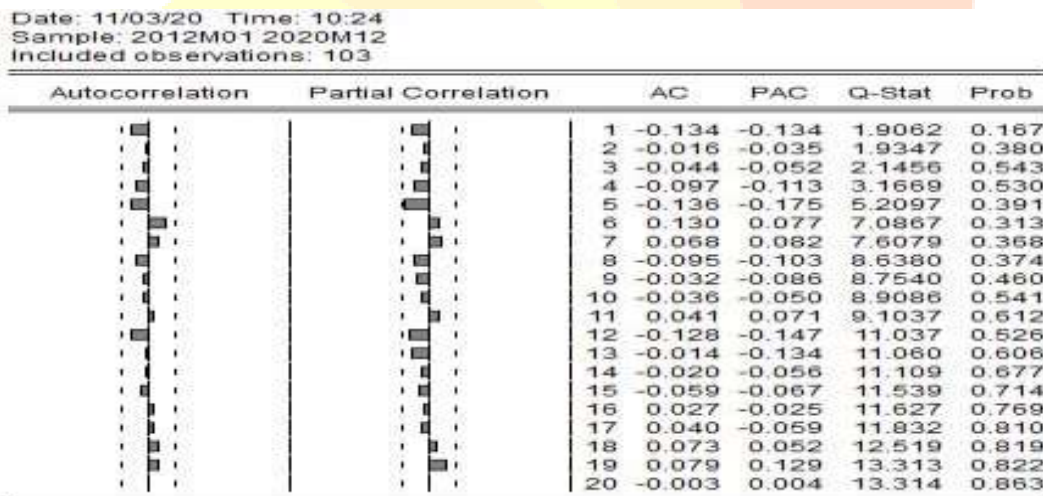


Figure (4) self-correlation function and partial self-correlation after taking the first difference

**Second: assessment phase :**

In order to estimate the best standard models for predicting bitcoin prices, Experimentation can be carried out taking into account the statistical conditions and criteria adopted in the box methodology -

More than 20 models were estimated through the Eviews 10 computer package, ranging from ARMA models at different slowdowns (1,0,1), (1,1,1) and (2,11) as well as ARIMA models for the logarithmic models of bitcoin prices. 2), this is due to many reasons, the most important of which is the number of

moral parameters(3), the decrease in the value of the dispersion coefficient (sigma2) and the rise in the value of the determinant

coefficient (R2) corrected as well as other parameters referred to in the phase Diagnosis

Table (2) estimated standard model ( ARIMA (1,0,0

Dependent Variable: LNPTC1  
 Method: ARMA Maximum Likelihood (BFGS)  
 Date: 11/06/20 Time: 10:29  
 Sample: 2012M01 2020M08  
 Included observations: 104  
 Convergence achieved after 9 iterations  
 Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.592370	2.949035	1.896339	0.0507
AR(1)	0.994263	0.016031	62.01931	0.0000
SIGMASQ	0.143921	0.009946	14.47085	0.0000
R-squared	0.972346	Mean dependent var	6.543205	
Adjusted R-squared	0.971799	S.D. dependent var	2.292369	
S.E. of regression	0.384963	Akaike info criterion	1.000067	
Sum squared resid	14.96783	Schwarz criterion	1.076348	
Log likelihood	-49.00350	Hannan-Quinn criter.	1.030971	
F-statistic	1775.660	Durbin-Watson stat	2.116801	
Prob(F-statistic)	0.000000			
Inverted AR Roots	.99			

Source: prepared by researchers based on the Eviews 10 program

Third: the stage of diagnosis of bitcoin models :

We note from Table (3) there are three models that can be compared among themselves to choose the best standard

model, but the logarithmic model (ARIMA (1,0,0) is superior to other models in many criteria, including the high value of the corrected selection factor (R2) (adj) and the low value of the dispersion factor as well as the low value of the :

Table (3) quality and accuracy prediction tests for ARIMA models

NO	Standards	ARIMA(1,0,0)	(ARIMA(1,0,1)	(ARIMA(2,0,2)
1	NO. sig	3	3	3
2	Sigma <sup>2</sup>	0.14	1821684	0.27
3	R <sup>2</sup> (adj)	97%	87%	94%
4	AIC	1.00	17.35	1.67
5	Sc	1.07	17.45	1.78
6	S.E	0.38	1376.42	0.53
7	Sum. S.E	14.96	189455108	28.10
8	MAE	4.26	2826.77	4.29
9	MAPE	61.27	1586.56	58.94
10	Theil U <sub>1</sub>	0.49	0.41	0.46
11	Theil U <sub>2</sub>	8.89	63.22	8.68
12	ACF , PACF test ( residul)	Accepted	Accepted	Unacceptable

Source: prepared by researchers based on the Eviews 10 program

The function of self-Association and partial self-Association ( ACF , PACF) of the spores also reveals that the estimated model

ARIMA(1,0,0) is statistically acceptable because the spores are within the limits of trust (95%) as shown in Figure 5 .

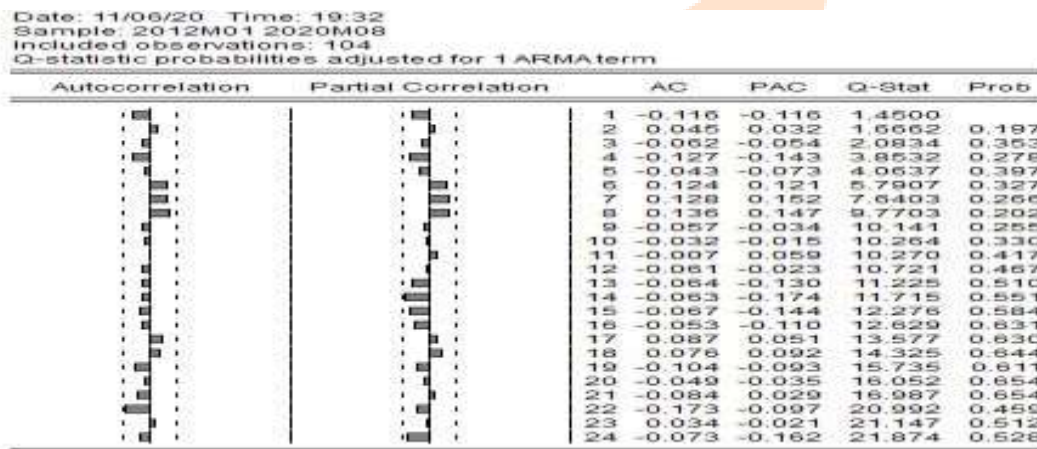


Figure (5) self-correlation function and partial self-correlation of the remainder of the estimated model (ARIMA (1,0,0))

Following the standard model audit, the model ARIMA ( 1,0,1) can be excluded as a result of the high values of both the dispersion coefficient (Sigma2), the standard error, the sum of the error squares and the average absolute values of errors (MAPE), while the model ARIMA ( 2,0,2) is statistically acceptable since the values of the statistical tests are close to the model ARIMA ( 1,0,0 , PACF for the remainder lies outside the 95% trust boundary, although we will try to proceed with the estimation and comparison of models ( ARIMA(2,0,2) and ARIMA (1,0,0) and predict bitcoin prices, meaning that acceptance of some statistical criteria gives way to prediction, but acceptance and compatibility of most criteria gives the standard model an advantage in the economic prediction process .

**Fourth: Bitcoin price prediction phase :**

The foregoing includes, I'm way to ( Box-Jenkins) rely on standard models with experimental nature which is based on the methods of operation and the selection and acceptance of the optimal models depends on the statistical standards which, looking at the quality and efficiency of standard models as well as their acceptance in economic terms .

Based on the foregoing, bitcoin values can be predicted during the four months (September, October, November, December) of 2020 and compared with the market value (truth ) of bitcoin prices as in Table 4, the use of the Box - Jen method will allow investors, whether individuals or financial institutions, to choose the optimal standard model based on economic as well as statistical and :

- The ARIMA model (1,0,0) indicates that bitcoin prices are trending higher during the study period and this is consistent with the trends of the optimistic investor .

- ARIMA(2,0,2) indicates that bitcoin prices fluctuate up and down, but also indicates that bitcoin prices are rising .

- When comparing the (real) market prices of bitcoin with the predicted prices, we note that the prices of bitcoin rise gradually during the study period, as indicated by the standard model(ARIMA (1,0,0).

Table (4) Comparison of true and predicted bitcoin prices / dollars.

Months	ARIMA(1,0,0)	ARIMA(2,0,2)	Market values
2020m9	11613.73	11444.52	11380
2020m10	11621.49	11788.72	12120
2020m11	11628.94	11463.04	16150
2020m12	11636.09	11799.83	21780

Source: researchers

It should be noted here that the prices of bitcoin continued to rise gradually and were not affected by the presence of negative factors such as the corona shock and Facebook's announcement of the release of Libra in June 2020 as well as the presence of many competing currencies , and when checking the market value of bitcoin we note a significant rise in :

1. Various global financial markets have stumbled as a result of the corona pandemic and its serious implications for the real economy sectors .

2. Individuals and institutional investors are starting to look for new payment methods, as well as appropriate investment tools that go beyond the fallout of the corona pandemic .

So I use the digital currency one of the most important options and investment, and this shows that these currencies such as bitcoin will not be a bubble, as some would, but will do its role in changing the global monetary system .

**CONCLUSIONS :**

1-digital currencies, including bitcoin, are not a bubble but are a tool for changing and developing the global economy because they

have relative acceptance as well as performing the functions of other money .

2-bitcoin prices were not affected by external shocks, including the fallout of the corona pandemic and the announcement (Facebook) of the release of a new currency called Libra

3-box-Jenkins methodology can be used in the short-term forecasting process because of its statistical criteria and conditions, but acceptance of the optimal standard model depends on the compatibility of statistical and economic standards .

#### **PROPOSALS :**

1. use the Box-Jenkins methodology in the process of forecasting and based on statistical and economic criteria to obtain the best standard models in the short term .

2. Bitcoin can be invested in short-term speculative operations as well as used as a medium-or long-term store of value .

3. central banks (Federal) to reconsider the issue of non-recognition of digital and appropriate legal standards within a new international convention .

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