

The Impact of the Money Supply of Cryptocurrencies on Monthly Inflation in the USA - January 2010 to July 2022

¹ Bendiba Yamina

¹university Ahmed Draia adrar, algeria, yam.bendiba@univ-adrar.edu.dz

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ABSTRACT

Four decades ago, the monetary authority in the United States of America was able to control inflation rates, which sometimes knew negative rates, but has not known similar rates like those it has known since April 2021. This research examines the relationship between inflation in the United States of America - which has not known similar rates like those it has known since April 2021 - with the Bitcoin money supply being the most traded cryptocurrency from January 2020 to July 2022, Based on the correlation coefficient, the Johansen-Jeselius cointegration test, in addition to the Granger Causality Test, the results of statistical and standard studies of these tests have been proven. and we have found through the standard study that there is a strong positive relationship between the two variables, and that the change in the trading volume of Bitcoin significantly affects inflation rates in the United States. This is based on monthly data for both Bitcoin trading volume as the most traded and accepted digital currency, and the consumer price index in the United States of America as the best measure that can be relied upon to express the change in the rate of inflation. While the study proved that there is no significant impact of the inflation rate on the supply of traded bitcoins.

Introduction

Two decades ago, the global economy witnessed a boom in the field of money and cash, with the emergence of what is known as digital currencies, which took a wide range of attention among individuals and governments, and even religious beliefs and legal legislation, some of them permitted dealing with it, some prohibited it completely and others have emulated and modified it and created a formula that suited the economic realities of the country.

With globalization and the rapid spread of information, digital currencies have become an inevitable reality, With the passage of time, many around the world have become receptive to them in order to settle their transactions, some countries even considered it an official currency, such as currency notes and many of them are adopting the same approach; therefore, these currencies have become a destination for many to invest in due to the continuous rise in their value - especially in the economy of the United States of America - despite being high-risk assets, hence, we find that the entry of this mass of money - if the name is correct - into the economy cannot be devoid of the impact on economic indicators in the short or long term.

Inflation is one of the most important economic indicators that aims to stabilize and maintain it at low levels, this is what the American economy has been able to achieve for several decades, but since 2020 gradually high rates have been recorded until it reached the highest level in more than forty years, this coincided with the explosion in the value of digital currencies, on top of it Bitcoin whose value moved from \$0.003 in 2020 to more than \$60,000 in October 2021.

This research paper discusses the problematic extent of the impact of the Bitcoin money supply on the monthly inflation level in the United States of America, this is based on monthly data for both the volume of Bitcoin trading, as

it is the most widely traded and accepted digital currency, and the Consumer Price Index in the United States of America as the best reliable measure for expressing the change in the inflation rate.

Therefore, the importance of the study in question stems from the novelty of digital currencies, whose impact on economic indicators is not yet known, especially with the high inflation that the American economy has known. The study is trying to find out the impact of the money supply of digital currencies on monthly inflation rates.

This study aims at a standard study of the relationship of the bitcoin money supply with the monthly inflation index in the United States during the period from January 2010 to July 2022, in order to find out the extent of the correlation and the effect that the independent variable has on the dependent variable.

There are many studies that have dealt with the two variables - inflation and digital currencies - but the study of the relationship between the supplies of digital currencies on inflation rates has rarely been addressed, from these studies:

- A study (Wasai Rabeih, Ramli Muhammad 2022) entitled: The effect of the money supply of virtual currencies on the inflation rate in Germany during the period (2014-2019), which aims to show the impact of the money supply of virtual currencies on the inflation index in Germany, and it found a long-term relationship between the variables of the study, it found that the correlation of the prices of these currencies with commodities and the major currencies, as well as the extreme fluctuations in the value of these currencies led to price inflation.

- A study (TIM MCMAHHON, 2018) Cryptocurrency and inflation, this study dealt with the effect of bitcoin and Ethereum trading on inflation, as it found that the correlation of the prices of these currencies with commodities and major currencies, as well as severe fluctuations in the value of these currencies led to price inflation.

- A study (Abdullah bin Suleiman bin Abdulaziz, 2017) entitled "Virtual Money: Its Concept, Types and Economic Effects," This study dealt with virtual money as an innovative means of payment, and its economic effects, in the end, it found the fragility of its infrastructure, which exposed it to a number of tremors and fluctuations in prices at the simplest of situations.

1- Theoretical framework for the impact of (digital) cryptocurrencies on inflation rates

1.1-The concept (digital) cryptocurrency:

Digital currencies are one of the modern payment methods that are widely used for ease of circulation and low cost, as well as the speed of its use to settle transactions without the need for an intermediary, in this element of the research, its definition, origin and characteristics will be discussed.

1.1.1- Definition of (digital) cryptocurrency:

From its name, digital currencies refer to a form of intangible digital exchange, as it is the name given to a system that uses cryptography to allow the extension, transmission and secure exchange of digital tokens in a distributed and decentralized manner (Eli Dourado, 2014, 1).

The World Bank Group also defines digital currencies as "the first and most advanced application of blockchain technologies, where money is made without the intervention of the central bank, and payment facilities are provided without financial institutions" (World Bank Group, 2018, 21).

And in another definition of digital currencies, it is considered as a form of exchange that only exists digitally, and is not backed by a physical commodity and does not exist in a physical form, It is also not linked to any physical currency, although digital currencies are often priced by exchanging them against other currencies such as the US dollar (Henri Vente, 2018, P 4-5). (Henri, p6) adds that digital currencies allow one party to transact directly with the other without the need for an intermediary... This saves the exorbitant fees and transaction costs charged by banks and payment merchants.

Therefore, digital currencies are no more than a form of exchange that individuals accept as a means of intangible payment, through which payments and transactions between parties are facilitated without government intervention, and without costs.

It is the electronic form of paper currency and coins that can be stored in the digital wallet, and the digital currency can be converted into cash on hand if necessary, by withdrawing cash from any ATM (automated teller machine) or bank.

In the world of cryptography, digital currencies are a program written in a specific programming language, using high encryption techniques that make penetration or manipulation almost impossible (Wasee, 2022, p. 42), this mitigates the risk that it is not subject to the control of an official body, and its value is subject to supply and demand, and therefore its future value cannot be predicted.

From the above, digital currencies can be known as a form of digital exchange that is not subject to central control, allows all transactions to be conducted without an intermediary or additional fees, and enjoys a high degree of security as it uses high encryption techniques, and its value is subject to supply and demand.

1.1.2- Characteristics of digital currencies

Digital currencies have a number of characteristics that distinguish them in many from cash currencies. These characteristics can be extracted from the above definitions:

- Intangible currency (non-physical or virtual).
- represents a form of exchange.
- Not subject to central control.
- Not supported by any official body and your central bank.
- They are traded without an intermediary.
- Penetrating it is almost impossible.
- Their value is subject to supply and demand, and the evolution of their value cannot be predicted in the future.
- Free and inexpensive trading (no fees or taxes).

1.1.3- The mechanism for the appearance of digital currencies

-The real emergence of digital currencies in their true form preceded several attempts to create them:

In 1997, Leonard Ullman, Shamir Addy, and Ronald Rivest of the Massachusetts Institute of Technology invented the RSA algorithm, which is the core idea of digital currencies (Ahmed Yahya Muhammad Ali, 2021, 133).

-In 1998, computer engineer Wei Dai presented a paper discussing "B-money," i.e. the idea of digital currencies that can be sent with a set of untraceable digital aliases (Ludovic Lars, 2020).

-In the same year, Nick Szabo's attempt is represented by "Bit Gold", where the idea was driven by the inefficiency of the traditional financial system, such as requiring the presence of metal to create coins (Kristy Moreland, 2022).

- The most mature initiative after these previous attempts was in 2008 launched by a person named "Satoshi Nakamoto" in a research paper entitled "Bitcoin is a peer-to-peer electronic currency system", in which he explained the functions of the Bitcoin blockchain network (Satoshi Nakamoto, 2008), in the same year, he created the "Blockchain" - which means an information network that contains a set of devices and nodes, where each device represents a database in which it maintains all transactions that take place within the network, which documents the safety of the procedures between the parties, then mining the first block of the Bitcoin network, which is known as the genesis block.

-2010 making the first recorded purchase of goods using Bitcoin for 10.000 BTC, and in March of the same year, the first cryptocurrency (digital) trading platform called "Bitcoinmarket.com" - which no longer exists - was created (Kristy Moreland, 2022).

-Beginning in 2011, digital currencies witnessed rapid developments, as the value of one unit of Bitcoin in January 2011 amounted to more than 0.3 dollars, with a trading volume of 377.75 thousand traders, with crossing the threshold of one million units traded for the first time in June 2011 with 1.36 million traders (Investing.com), the same year knows the emergence of other cryptocurrencies, including "Altcoins", which is a branch of Bitcoin.

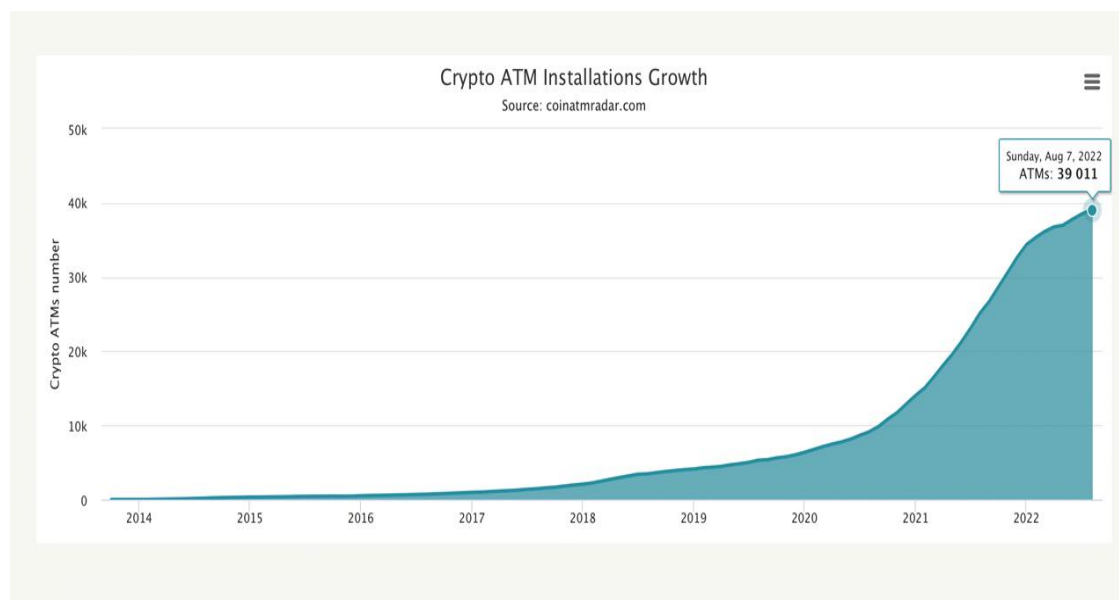
-The year 2012 witnessed the beginning of accepting Bitcoin as a form of payment at official merchants on Internet sites, such as the "WordPress" website, and the "Microsoft" website (Ismail Al-Amrawi, 2021, p. 7).

-The year 2013 was the year in which it was known that bitcoin trading prices against the dollar crossed the \$100 threshold for the first time in its history, in the month of April, when its trading price reached \$139, which is the real

launch of the value of Bitcoin (Invetig.com), especially with the opening of the first Bitcoin ATM in Vancouver, Canada in 2013 (Marc Cieslak, 2013).

Since then, the digital currency infrastructure has continued to develop, reaching 10,000 ATMs in 2020, after it crossed the 1000-machine threshold in January 2017, and in August 2022 it will exceed 39.000 machines spread across the world (Jamie Redman, 2022). The following figure shows the evolution of the number of automated teller machines for digital currencies from 2014 to the present day.

Figure 1: The evolution of the number of cryptocurrency ATMs around the world from 2014 to 2022



Source: <https://news.bitcoin.com/the-number-of-cryptocurrency-atms-installed-worldwide-surpasses-39000/>

Through the above figure, we notice that the evolution of the number of automated teller machines for digital currencies was simple until 2017, after that, these ATMs witnessed a significant increase, as we notice the doubling of their numbers from year to year, until it reaches its peak in 2022 with a number of approximately 40,000 ATMs, which reflects the great openness and demand for digital currency trading.

1.2- Inflation in the economic literature

Inflation is one of the most important indicators of interest to economists, politicians, and even the public, and the mechanism for controlling it has often taken place in the discussions of decision-makers in economic policies.

In general, inflation is defined as the rise in prices during a certain period of time, and in a somewhat broader sense it is the rise in prices or the cost of living in a country (CeydaOner, 2010, p44).

Economic literature indicates that there is a difference in explaining the phenomenon of inflation and justifying its causes. There are those who defined it as a monetary phenomenon, and some of them defined it as linked to the general level of prices:

1.2.1- The Keynesian explanation for inflation

Peru's definition, up to him inflation is a result of an increase in the money supply, i.e. an increase in ready money (Belazouz Ben Ali, 2006, p. 140). Therefore, he believes that inflation is the increase in available money without the increase in commodities and services that correspond to it, which is supported by the Keynesian school when it considered that the continuous increase in the money supply will lead to an increase in aggregate demand, which leads to the continuation of the rise in prices, which causes inflation.

1.2.2- Friedman's interpretation of inflation

And there are those who believe that inflation is the situation in which the real value of the currency unit decreases when prices begin to rise, according to the definition of Courtier, who explains inflation as a decrease in the value of money and a rise in prices at the same time, which Friedman supports (Sami Khalil, 1994, P. pp. 1514-1515).

Friedman's theory appeared, he opposed this definition of the Keynesian theory, which considered that the money supply is determined by the monetary authority, and that changes in this supply determine the volume of goods and services in the short term, and determine the general level of prices, which leads to a decrease in the value of money, that reduces the motivation to retain them, which leads to inflation.

This corresponds to the inflation that afflicted the German economy after the First World War between the years (1921-1923), when the German government needed to rebuild the economy, which prompted it to increase government spending to exceed revenues, so it resorted to printing new money - after excluding resorting to financial policy tools - which led to an increase in the money supply, and it began to grow rapidly, which affected prices by an increase (Sami Khalil, pp. 1503, 1504).

In conclusion, we find that both Keynesian theory and Friedman's agree that inflation occurs when the money growth rate rises, however, the first one believes that this increase leads to an increase in aggregate demand, which leads to an increase in prices, so that inflation becomes an inevitable result, while Friedman believes that "inflation is always and everywhere a monetary phenomenon."

1.3- The possible impact of digital currency on inflation rates (theoretically)

Until 2008 - the year of the launch of digital currencies - central banks remained the sole control over the issuance of cash currencies, and that is according to its available versions, such as gold and drainage reserves from hard currencies, until the digital currencies appeared in a new pattern in the release outside all controls, and it is not subject to central power similar to the coins, So that the metal issuance- i.e. issuing new digital currencies- is subject to supply and demand.

And because digital currencies have become a reality and have an impact on the economies of the countries that allowed and circulated, it has become important to show any impact on them on the width of the total money.

1.3.1-The possible effect of inflation rates

Digital currencies allow additional exchange of the economy other than that of the legal, and with the infinite possibility to generate these currencies; this is all reflected in the volume of money within the economy in its narrow concept (M1), which will increase, this will contribute to the high inflation rates, as their issuance will be free of charge from the production of goods and services, although this money will not be part of the central bank standards for the volume of money, it will lead to an increase in the total supply of money within the economy, but it is not taken into account when taking economic policies (on the behalf of Abdullah bin Sulaiman Abdul Aziz, 2017, pp. 903-904).

1.3.2 -The probable impact of monetary policy

Because the use of these currencies is possible for everyone and it is done without a mediator or cost, and inasmuch that most e-commerce transactions are carried out in these currencies, it may lead to a lack of demand for legal money, it is the matter of the central bank's inability to choose the appropriate monetary policy.

2- Study the effect of bitcoin trading on inflation rates in the United States of America

2.1- The development of monthly inflation rates in the USA and monthly trading value of Bitcoin from 01-2011 to 07-2022

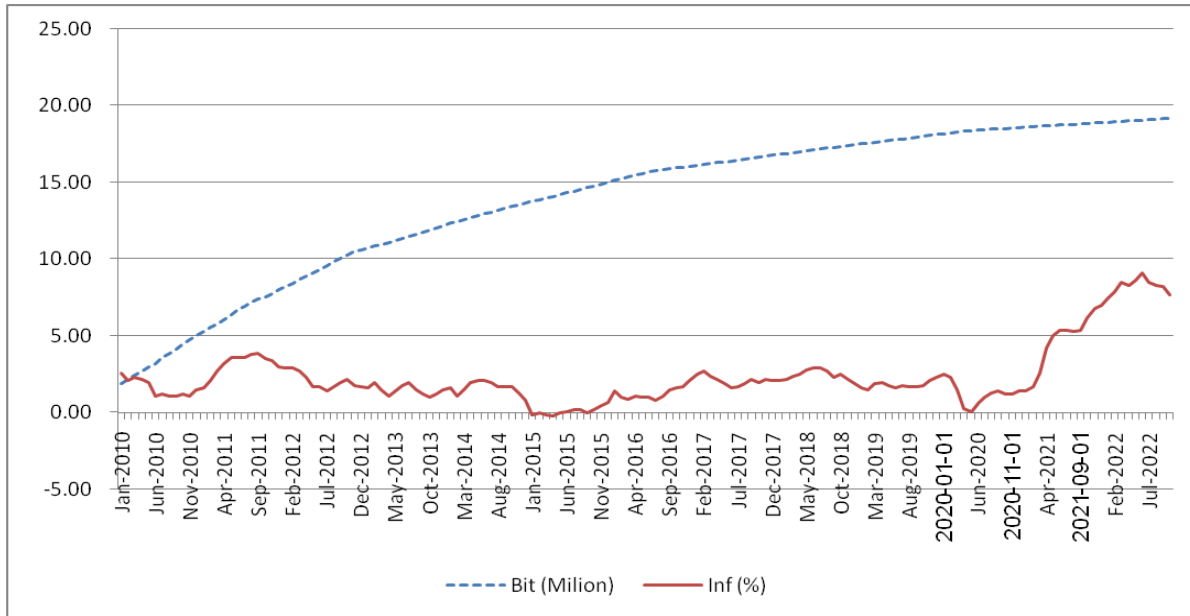
Since the global recession crisis in 2008, the United States of America has pursued an expansion monetary policy for the purpose of reviving the economy, by setting interest rates at zero for the period between 2009 to 2015 (Roert J. Barro, 2022), however, inflation rates remained low, with an average of about 2% annually from 2009 to 2019, with the highest value during this period, at 3.8 % at the end of 2011, and it reached below zero percent in 2015.

But from March 2021, inflation rates gradually increased from 4.2% April 2021, to 9.1% of June 2022 as the highest rate of the American economy four decades ago.

While the Bitcoin trading volume has been constantly evolving at a rapid pace, moving from 1.87 million units at the beginning of the study to 19.19 million units in October 2022.

the following curve shows the evolution of the monthly inflation rates in the United States of America, and Evolution of Bitcoin's Monthly Turnover from January 2010 to July 2022:

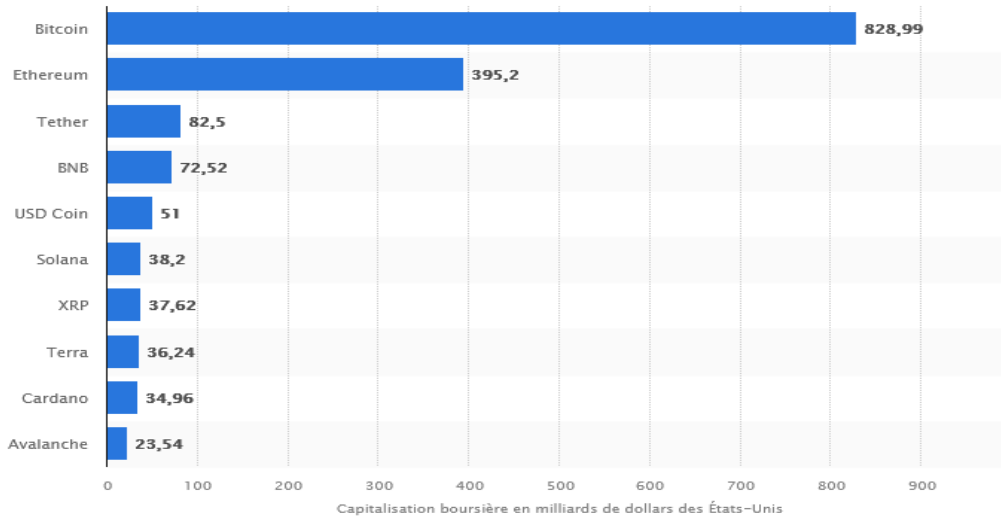
Figure 02: Evolution of monthly inflation rates in the USA and monthly trading value of Bitcoin from 01-2010 to 07-2022



Source: Preparing the researcher based on the statistics contained on the site: <https://www.usinflationcalculator.com/inflation/current-inflation-rates/> and <https://www.statista.com/statistics/247280/number-of-bitcoins-in-circulation/>

On the other hand, the US economy is the largest economy in the world, and one of the most open, and among the many economies that allowed its people to issue and trade digital currencies, where these currencies have known a great demand from individuals since their inception, as Bitcoin is the first digital currency to be issued - it appeared in 2009 - and it is the most accepted and traded, and the highest in terms of market value, and it has a significant impact on the rest of the digital currencies in the market, after its success and high market value, many other digital currencies appeared, such as Ethereum, ETH, Litecoin, LT, Ripple, BNB, and USD coin. The following chart shows the trading volume of the most important digital currencies compared to Bitcoin, as well as the evolution of the trading value of Bitcoin.

Figure 03: Trading volume of the most important cryptocurrencies



Source: <https://fr.statista.com/statistiques/664588/valorisation-boursiere-principales-monnaies-virtuelles-monde/>

2.2- Testing the causal relationship and co-integration between Bitcoin trading volume and inflation rate in the US

2.2.1- Study methodology

In order to test and discuss the dialectical relationship between Bitcoin trading volume and inflation rate in the USA during the period 2010-2022, In this advanced part of the study, we resort to the method of economic measurement,

Based on a set of statistical and standard tools suitable for this purpose, mainly the correlation coefficient, the Johansen cointegration test, and Granger Causality.

2.2.2- Study variables

In order to achieve the objectives of the applied study, the study variables were selected based on both economic theory and standard models used in previous studies, Monthly data on Bitcoin (BTC) trading volume (units in millions) and the US Consumer Price Index (CPI) were relied upon as the best reliable measure of the change in the inflation rate, for the period 2010M01-2022M07 with a total of 151 views, and the monthly data of the two study variables was obtained from the OECD Stat database for the US Consumer Price Index (CPI), while the monthly data for Bitcoin trading volume (BTC) was obtained from Statista.

Table (01) shows the most important statistical characteristics of the variables (BTC) and (CPI) during the study period, as follows:

Table 1: Statistical Characteristics of the Study Variables

	CPI	BTC
Mean	102.9230	13.81391
Median	100.8333	15.49000
Maximum	124.6020	19.11000
Minimum	91.63857	1.870000
Std. Dev.	7.431437	4.790187
Skewness	0.794426	-0.881141
Kurtosis	3.367389	2.684722
Jarque-Bera	16.73220	20.16503
Probability	0.000233	0.000042
Sum	15541.38	2085.900
Sum Sq. Dev.	8283.939	3441.884
Observations	151	151

Source: made by researcher used outputs of eviews 12

2.2.3- Study the nature and strength of the relationship between Bitcoin trading volume and inflation rate

Although the study of the correlation coefficient between variables does not make it possible to know who is the interpreting variable and who is the interpreting variable, But it is very important because it illustrates the nature of the relationship between variables (positive or negative) and the strength of the relationship between these variables. For the variables under study, the results of the correlation coefficient study were shown in the following matrix:

Table 2: Correlation coefficient matrix between Bitcoin trading volume and inflation rate

	CPI	BTC
CPI	1	0.86
BTC	0.86	1

Source: made by researcher used outputs of eviews 12

The results shown in Table 2 indicate a positive and strong correlation between Bitcoin (BTC) trading volume and inflation rates in the United States of America (CPI), and therefore this result is fully consistent with the study's prior expectations.

2.2.4- Unit root testing for time series (ADF) and (PP) Stillness

We used the unit root test to identify the degree of

integration of the time series of the economic variables under study to see if the variables are stable or not, and we will rely In this study on the Dickey-Fuller extended test (ADF) and the Plips Perron test (PP), both of which are based on testing the null hypothesis that the unit root exists in time series (i.e., time series instability).

a. Augmented Dickey Fuller test (adf)

The Dickey- Fuller Test can be performed according to the following equation with the constant (β_1) and the temporal direction (t) of the variable (Y):

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \varepsilon_t \dots\dots\dots (1)$$

In this model, it was assumed that there was no autocorrelation between the error limits, but if there was autocorrelation, the model became inappropriate and made the estimation results inaccurate. In order to overcome this situation, this model was developed or expanded by adding decelerating values to the time series under analysis to be later known as the Augmented Dickey- Fuller Test, and the model took the following formula:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum \alpha_i \Delta Y_{t-i} + \varepsilon_t \dots\dots\dots (2)$$

The time series rest test depends on the significance of the parameter (δ), by comparing the calculated (t) with the tabular (δ), if the calculated value is greater than the tabular it means that the time series is static at the plane, and this time series is non-static if the calculated value is less than the tablar, in which case it is necessary to take the first difference.

b. Phillips- Perron test

The Phillips & Perron test (PP) (Phillips & Perron, 1988) is based on equation (1) but differs from the ADF test in addressing higher-order serial correlation, as it uses non-parametric statistical methods to take into account serial correlation within error limits without adding slowing difference limits.

Table (03) shows the statistical results obtained after performing the augmented Dickey- Fuller Test (ADF) and the Phillips- Perron test (PP) at the level and at the first differences, and includes the critical values of each test at the level of significance (5%) and the accompanying probabilities.

Table 3: Results of Augmented Dickey- Fuller Test (ADF) and Phillips- Perron Test (PP)

	Phillip-perron test (PP)		augmented Dickey- Fuller Test (ADF)	
	At level I(0)	At the first differences I(1)	At level I(0)	At the first differences I(1)
CPI	[4.6056] (1.0000)	[-4.6513] (0.0000)	[3.7827] (1.0000)	[-2.6060] (0.0093)
BTC	[2.5825] (0.9977)	[-2.2607] (0.0234)	[0.1130] (0.7169)	[-2.1687] (0.0294)
Obs	[]:The values inside the crossbars indicate the critical values of the t statistic ():The values inside the parentheses indicate the probability corresponding to the t-statistic			

Source: made by researcher used outputs of reviews 12

The results of Table (03) indicate that the time series for both Bitcoin (BTC) trading volume and the US Consumer Price Index (CPI) were not static at their levels. The Dickey-Fuller extended test (ADF) indicated that the calculated Dickey-Fuller values were lower than the corresponding tabular values, at a statistically significant level of 5%.

Therefore, the null hypothesis that BTC and CPI are not stationary at their levels is accepted. However, after taking the first differences of the two variables, the time series of the two variables became static, so that the calculated Dickey-Fuller values for both variables were greater than the tabular values at a significance level of 5%, they are integral of degree I(1).

Philips-Perron test results also tend to have no BTC and CPI at the level, When the test was repeated after the first differences were taken, the two variables became static (i.e. integral I(1)), and these results are exactly the same as the results of the augmented Dickey-Fuller test (ADF).

2.2.5- Co-integration test

Time series stability tests for both Bitcoin (BTC) trading volume and the US Consumer Price Index (CPI) confirmed that they are unstable series, While it was shown that it stabilizes after taking its first differences, in the sense that it is integrated of the same degree I(1). The cointegration test can then be performed by the Johansson cointegration test method, To ascertain the extent to which there is a long-term equilibrium relationship between the trading volume of Bitcoin and the consumer price index in the USA.

The Johansen-Jeselius (1990) approach to cointegration proceeds from the estimation of the following VAR(K) autoregression beam model:

$$X_t = \Pi_1 X_{t-1} + \dots + \Pi_K X_{t-K} + \varepsilon_t \dots\dots\dots (3)$$

So X_t represents a vector containing the study variables, while K represent the number of time gaps included in the model, Because the study variables are unstable at the level, the previous relationship can be formulated after taking the first differences of the study variables as follows:

$$\Delta X_{t-1} = \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-K} + \varepsilon_t \dots\dots\dots (4)$$

So that: $\Gamma_1 = -(I - \Pi_1, \dots, -\Pi_1)$, $(i = 1, \dots, k-1)$, $\Pi = -(I - \Pi_1, \dots, -\Pi_k)$

According to Johansson's methodology, the matrix Π in the second relationship can be decomposed into two matrices α and β dimensioned $(N \times r)$ as follows:

$$\Pi = \alpha \beta$$

where the matrix represents β cointegration vectors r (interintegration relationships between unstable variables), While the matrix α expresses the speed of adjustment towards equilibrium for each beam of cointegration. To estimate the matrices α and β Johansson used the maximum possibility method, and identify two tests to detect the number of cointegration vectors. The first is called a trace test to test the null hypothesis H_0 that there are a number of integration vectors equal to at most r , As opposed to the H_1 alternative hypothesis, which states that there are a number of integration vectors exceeding r , the effect statistic can be calculated according to the following formula:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^p \ln(1 - \hat{\lambda}_i) \dots \dots \dots (5)$$

And The null hypothesis is rejected when the calculated λ_{trace} statistic is greater than the tabular value at a given significance level. The second test is the Maximum Eigenvalue test to test the H_0 null hypothesis that the number of integration vectors is r , As opposed to the H_1 alternative hypothesis that the number of these vectors is $r+1$. The statistics of this test can be formulated according to the following relationship:

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \dots \dots \dots (6)$$

And The null hypothesis is rejected when the calculated λ_{max} statistic is greater than the tabular value at a given significance level.

However, before the JCS cointegration test can be performed, the optimal delay period (p) in the previous relationship (4) must be determined.

a. Determining the optimal time deceleration period: Table (4) illustrates the results of determining the Lane Delay Period (VAR), through the results of a set of criteria as follows:

Table 4: Determining the Optimal Deceleration Period

VAR Lag Order Selection Criteria						
Endogenous variables: CPI BTC						
Exogenous variables: C						
Sample: 2010M01 2022M07						
Included observations: 143						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-796.2449	NA	241.8965	11.16426	11.20570	11.18110
1	329.5932	2204.438	3.71e-05	-4.525779	-4.401463	-4.475263
2	362.9306	64.34352*	2.46e-05*	-4.936092*	-4.728900*	-4.851899*
3	365.3227	4.550040	2.52e-05	-4.913604	-4.623535	-4.795734
4	367.0676	3.270095	2.60e-05	-4.882064	-4.509118	-4.730516
5	369.7032	4.865845	2.65e-05	-4.862982	-4.407160	-4.677758
6	373.0460	6.077717	2.68e-05	-4.853790	-4.315091	-4.634888
7	374.6959	2.953819	2.77e-05	-4.820922	-4.199347	-4.568344
8	379.4919	8.451524	2.74e-05	-4.832054	-4.127601	-4.545798
* indicates lag order selected by the criterion						

Source: made by researcher used outputs of eviews 12

The optimal delay period is determined on the basis of the lowest value for the following criteria: AIC, SC, PPE, HQ, and on the basis of the highest value for the LR, so that the selection falls on the period on which all standards agree, and in the absence of a difference between these criteria, the appropriate delay period is determined on the basis of the period agreed upon by the majority of the criteria. Therefore, the appropriate delay period in this study is the period that meets all the aforementioned criteria, which is two months (i.e. $P=2$).

b. Results of the Johansson Cointegration Test:

After determining the optimal delay period, and after estimating the autoregressive vector model VAR(2), it becomes possible to perform the Johansson cointegration test, the latter of which is based on two tests: the trace test, and the maximum value or maximum potential test, as follows:

Table 5: Johansson Joint Integration Test Results

Ho	H1		0.05 Critical Value	Probability
r=0	r=1	λ trace value 52.37854	15.49471	0.0000
r<=1	r=2	16.28130	3.841465	0.0001
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level				
r=0	r=1	λ max tests 36.09725	14.26460	0.0000
r<=1	r=2	16.28130	3.841465	0.0001
Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level				

Source: made by researcher used outputs of eviews 12

Table (5) of the Johansson Cointegration Test shows the following:

a. Trace Test:

- The Trace statistic reached the value (52.37854), which is higher than the critical value of (15.49471) at a significant level of 5%, so we reject the null hypothesis (Ho) that there is no co-integration (r=0) between (BTC) and (CPI), and we accept the alternative hypothesis (H1) that there is a single vector of integration of the common (r=1) in the long term between the trading volume of Bitcoin (BTC) and the consumer price index in the United States of America (CPI).
- The trace statistic reached (16.28130), which is lower than the critical value of (3.841465) at a significant level of 5%, so we reject the null hypothesis (Ho) that there is a single vector of cointegration (r=1), and accept the alternative hypothesis (H1) that there is more than one vector of cointegration (i.e. r=2) in the long term between Bitcoin trading volume (BTC) and the consumer price index in the United States of America (CPI).

b. Maximum Eigenvalue test

- The (Max-Eigen) statistic reached the value (36.09725), which is higher than the critical value of (14.26460) at the level of 5% significance, so we reject the null hypothesis (Ho) that there is no co-integration (i.e. r=0) between (BTC) and (CPI), and accept the alternative hypothesis (H1) that there is a single common integration vector (i.e. r=1) in the long term between Bitcoin (BTC) trading volume and the US Consumer Price Index (CPI).
- The (Max-Eigen) statistic reached (16.28130), which is greater than the critical value of (3.841465) at a significant level of 5%, which means that we reject the null hypothesis (Ho) that there is a single vector of common integration (i.e. r=1). We accept the alternative hypothesis (H1) that there are two vectors of cointegration (i.e. r=2) in the long term between Bitcoin trading volume (BTC) and the US Consumer Price Index (CPI).

Through the results of the two tests, we confirm that there is a common integration relationship between the trading volume of Bitcoin (BTC) and the consumer price index in the United States of America (CPI), so that the results of these two tests confirm the existence of a linear and jointly integrated compatibility between (BTC) and (CPI), although the strings of these variables are non-static chains. These results also confirm the existence of a long-term equilibrium relationship between Bitcoin trading volume (BTC) and the US Consumer Price Index (CPI), which means that they do not deviate from each other and exhibit similar and similar behavior over time.

2.2.6- Causal Trend Test - Granger Causality Test

According to Granger (1988), if there is a long-term relationship between two variables, there must be at least a one-way causal relationship between these two variables in the short term. The meaning of the Granger causality test in this study involves the Fischer test (F) to verify whether the information provided about the variable (BTC) provides statistically significant information about the variable (CPI) in the presence of the slowed CPI. More precisely, Granger argues that the variable (BTC) causes the variable (CPI) if CPI value prediction was improved by involving information about the BTC variable in the analysis, if not, BTC does not cause CPI. Granger's causality test is based on the following equations:

$$\Delta BTC_t = \sum_{i=1}^n \alpha_i \cdot \Delta CPI_{t-1} + \varepsilon_t \dots\dots\dots(7)$$

$$\Delta CPI_t = \sum_{i=1}^n \beta_i \cdot \Delta BTC_{t-1} + \varepsilon_t \dots\dots\dots(8)$$

$$\Delta BTC_t = \sum_{i=1}^n \theta_i \cdot \Delta BTC_{t-1} + \sum_{i=1}^n \varphi_i \cdot \Delta CPI_{t-1} + \varepsilon_t \dots\dots\dots(9)$$

$$\Delta CPI_t = \sum_{i=1}^n a_i \cdot \Delta CPI_{t-1} + \sum_{i=1}^n b_i \cdot \Delta BTC_{t-1} + \varepsilon_t \dots\dots\dots(10)$$

To test the existence of a one-way or reciprocal causal relationship between Bitcoin trading volume and inflation rate in the United States during the study period, a Granger causality test was performed taking into account a two-month delay period, and Table (6) shows a summary of the results of this test.

Table 6: results of Granger Causality Tests

Granger Causality Tests				
Sample: 2010M01 2022M07				
Lags: 2				
(Ho) Null hypothesis	obs	F- statistic	Prob	decision
BTC does not cause CPI	149	3.26201	0.0412	We reject(Ho)
CPI does not cause BTC	149	0.49754	0.6091	Accept(Ho)

Source: made by researcher used outputs of eviews 12

These results show a one-way causal relationship from Bitcoin trading volume towards US inflation rate, indicating that the change in Bitcoin trading volume causes or affects the inflation rate in the US after a two-month delay from a BTC shock, Which means that there is a significant impact of changes in the trading volume of bitcoins on the inflation rate in the United States during the study period. While the results showed that the inflation rate in the United States does not cause the change in the trading volume of bitcoins during the same period, which means that the change in the inflation rate has no significant impact on the supply of bitcoins during the study period.

Conclusion

The study dealt with the measurement and analysis of the relationship between the volume of Bitcoin trading and the inflation rate in the United States of America during the period from January 2010 to July 2022, based on the correlation coefficient, the joint integration methodology of Johansen-Jeselius cointegration test, in addition to the Granger Causality Test, and the results of statistical and standard studies of these tests proved the following:

1. The existence of a strong positive relationship between the trading volume of bitcoins and the inflation rate in the United States of America during the study period;
2. The existence of a long-term equilibrium relationship between Bitcoin trading volume and the inflation rate in the United States;
3. The study also confirmed the existence of a one-way causal relationship from the trading volume of bitcoins towards the inflation rate in the United States, which means that the change in the trading volume of bitcoins (the supply of bitcoins) causes and significantly affects inflation rates in the United States. While the study proved that there is no significant impact of the inflation rate on the supply of traded bitcoins.

At the end of this study, we conclude that the increase in the money supply of digital currencies has shown its impact on inflation rates in the United States of America, which necessitates the imposition of a kind of central control over their creation and circulation, and we recommend linking their creation to real production.

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