ORIGINAL

Bitcoin Volatility: A Profitability-Focused Approach

Volatilidad del Bitcoin: Un enfoque centrado en la rentabilidad

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ABSTRACT

This study delved into the complex world of cryptocurrencies, analyzing their behavior, profitability, and volatility. Through a thorough and meticulous analysis of the 2021 – 2023 period, the volatile nature of these digital assets was revealed, where profits could be suddenly affected by external events. Bitcoin, two of the cryptocurrencies with the largest presence in the market, were the subject of a thorough analysis using sound statistical methodologies. Descriptive statistics were employed to characterize the overall behavior of cryptocurrencies, including measures of central tendency, dispersion, and distribution. Additionally, normality and stationarity tests were used to choose the best variant of the GARCH model, which was EGARCH, to estimate conditional volatility, future volatility and price profitability, allowing to identify patterns and dynamics in their variability. The results of the study revealed that cryptocurrencies, while presenting attractive potential returns, also carry a high degree of volatility. However, thanks to the in-depth analysis of the behavior of these assets we can identify opportune moments to make purchases, sales or strategic investments. The main goal of this study is to provide investors with the information needed to make strategic and informed decisions about their cryptocurrency investment.

Keywords: Bitcoin; Profitability; Volatility.

RESUMEN

Este estudio profundizó en el complejo mundo de las criptomonedas, analizando su comportamiento, rentabilidad y volatilidad. A través de un análisis exhaustivo y meticuloso del período 2021 – 2023, se reveló la naturaleza volátil de estos activos digitales, donde las ganancias podrían verse afectadas repentinamente por eventos externos. Bitcoin, dos de las criptomonedas con mayor presencia en el mercado, fueron objeto de un análisis exhaustivo utilizando metodologías estadísticas sólidas. Se emplearon estadísticas descriptivas para caracterizar el comportamiento general de las criptomonedas, incluidas medidas de tendencia central, dispersión y distribución. Adicionalmente, se utilizaron pruebas de normalidad y estacionariedad para elegir la mejor variante del modelo GARCH, que fue EGARCH, para estimar la volatilidad condicional, la volatilidad futura y la rentabilidad de los precios, permitiendo identificar patrones y dinámicas en su variabilidad. Los resultados del estudio revelaron que las criptomonedas, si bien presentan atractivos rendimientos potenciales, también conllevan un alto grado de volatilidad. Sin embargo, gracias al análisis en profundidad del comportamiento de estos activos podemos identificar momentos oportunos para realizar compras, ventas o inversiones estratégicas. El objetivo principal de este estudio es proporcionar a los inversores la información necesaria para tomar decisiones estratégicas e informadas sobre su inversión en criptomonedas.

Palabras clave: Bitcoin; Rentabilidad; Volatilidad.

INTRODUCTION

The market for cryptocurrencies, such as Bitcoin, has seen significant growth between the years 2017 and 2024. However, market has influenced the price, experiencing dramatic fluctuations (Mikhaylov, 2020). At the end of 2017, the price of Bitcoin experienced a remarkable growth, going from around USD 1000 to over USD 19 000, which represents a growth of 1800 %. In 2018, this exponential growth was followed by an abrupt drop, with the price falling below USD 4000 by the end of the same year, representing a drop of approximately 70 %. However, in 2019 the price of Bitcoin recovered, ranging from $3 500 to $ volatility 13 800. This volatility is driven by a combination of factors, including speculation, lack of clear regulation, the influence of the news, and the small size of markets compared to traditional assets.[1,2]

Cryptocurrencies are a type of digital money that can be used to purchase goods and services, invest, create smart contracts, play games, and access decentralized financial services. Their security and versatility make them an increasingly popular tool. There are more than 20 000 cryptocurrencies on the market, they are decentralized, which means that they are not controlled by any central entity.[3,4] This feature, coupled with the use of blockchain technology to record transactions, makes them a highly transparent and secure payment system. While cryptocurrencies offer many potential benefits, they also present some challenges and risks. [5,6] One of the main challenges is anonymity, which can facilitate illicit activities such as money laundering. However, solutions, such as digital identities and transaction traceability, are being developed to mitigate this risk.[7,8] Cryptocurrencies are also highly volatile, meaning that their value can fluctuate significantly. in a short period of time. In addition, the lack of regulation in some countries can generate uncertainty and facilitate illicit activities.[9,10,11]

METHOD

The information analyzed was obtained from the financial portal Yahoo Finance, which presents daily data with a cut-off every 24 hours, according to Coordinated Universal Time. This data is considered secondary because Yahoo Finance obtains it from various cryptocurrency exchange platforms, which collect information from multiple exchanges, which will be presented later in table 1.

Yahoo Finance is a trusted source of financial information for investors, traders, and people interested in the market. It offers a wide range of information, real-time data on stock prices, stock indices, cryptocurrencies, commodities, and more. It also offers news, analysis, research, and investment tools.

In order to analyze the behavior of cryptocurrency prices, 1095 updated closing price data were collected for each cryptocurrency (Bitcoin) for this study. The study draws on a robust dataset of 1095 observations to explore the price dynamics of Bitcoin.

RESULTS

Table 1. Bitcoin Cryptocurrency Stationarity Tests (KPSS, Dickey Fuller, Phillips Perron) by Day: 01/01/2021 - 31/12/2023

Test	Normal Series	Series with Logarithms	Series with 1 Logarithm and 1 Difference	Interpretation
KPSS	DE>DC (Stationary Node)	DE>DC (Stationary Node)	DE>DC (Stationary No)	The KPSS tests suggest that the Normal and Logarithm series are not stationary, while the series with 1 Logarithm and 1 Difference is.
Dickey-Fuller	DE>DC (Stationary)	DE>DC (Stationary)	DE>DC (Stationary)	The Dickey-Fuller tests indicate that all three sets are stationary.
Phillips-Perron	DE>DC (Stationary)	DE>DC (Stationary)	DE>DC (Stationary)	Interpretation: The Phillips-Perron tests coincide with the Dickey-Fuller tests, indicating that all three series are stationary.
ARIMA Model	ARIMA (1,0,0)	-	-	The ARIMA model of order (1,0,0) obtained for the Normal Series indicates that the series can be modeled with an autoregressive process of order 1. However, it is important to note the mixed evidence from stationarity tests for this series.

Note. Results of the stationarity tests and the adjustment of the ARIMA model for the time series of the closing price of the Bitcoin cryptocurrency, corresponding to the period 2021-2023.

In this table on the stationarity of data of the Bitcoin cryptocurrency, the values of the results were replaced by the acronyms DE and DC, it is important to mention that the formulation of the hypothesis for the KwiatkowskiPhillips-Schmidt-Shin (KPSS) test is different from the other tests having that H0: DE>DC: The data are stationary and H1: DE<DC data are not stationary for the other two tests, simply the hypothesis changes, it must be taken into account that the results of KPSS can lead us to make Type 1 errors, so it is necessary to take care of its values and it is the reason to apply more tests.

Table 2. Statistical Result of Bitcoin Daily Returns by Day 01/01/2021 - 31/12/2023			
Min.	2021-01-01	Min.	-0,1597473
1st Qu.	2021-10-01	1st Qu.	-0,0141047
Median	2022-07-02	Median	-0,0003419
Mean	2022-07-02	Mean	0,0009010
3rd Qu.	2023-04-01	3rd Qu.	0,0161257
Max.	2023-12-31	Max.	0,1874647

Note. This table describes the statistical results of the daily returns of the Bitcoin cryptocurrency in a period ranging from 2021 - 2023. Data extracted from the [12]

Table 3. Effects of GARCH Model Variants on Bitcoin Cryptocurrency					
	Akaike	**Bayes**	**Shibata**	**Hanna-Quinn**	**Box-Ljung test**
sGARCH	12,827	12,845	12,826	12,833	p-value = 0,6798
fGARCH	73,874	73,893	73,874	73,881	p-value = 0,2598
eGARCH	-4,0581	-4,0307	-4,0582	-4,0478	p-value = 0,4416
apARCH	-3,9673	-3,9399	-3,9674	-3,9570	p-value = 0,5238
TGARCH	3,8836	3,9064	3,8835	3,8922	p-value = 0,4009
AVGARCH	-3,9219	-3,8945	-3,9220	-3,9116	p-value = 0,9879
NAGARCH	-3,9507	-3,9278	-3,9507	-3,9420	p-value = 0,4939
APARCH	-3,9606	-3,9332	-3,9606	-3,9502	p-value = 0,553
GJRGARCH	5,9114	5,9342	5,9113	5,9200	p-value = 0,9074

Note. The table presents the variants of the GARCH model and the results of the Box-Ljung autocorrelation test for each variant applied to the time series of Bitcoin's daily closing prices.

The test results indicate that the time series of Bitcoin returns exhibit significant autocorrelation, suggesting that the eGARCH model is suitable for modeling the performance and volatility of the Bitcoin cryptocurrency.

Table 4. Descriptive Statistics of Bitcoin Cryptocurrency Volatility by Day: 01/01/2021 - 31/12/2023			
Min.	2021-01-02	Min.	0,01695
1st Qu.	2021-10-02	1st Qu.	0,02604
Median	2022-07-02	Median	0,03183
Mean	2022-07-02	Mean	0,03254
3rd Qu.	2023-04-01	3rd Qu.	0,03704
Max.	2023-12-31	Max.	0,06568
		Standard deviation	0,008533
		25 %	0,02603862
		50 %	0,03182947
		75 %	0,03703623

Note. This table shows the detailed result of the descriptive statistics of the conditional volatility of the Bitcoin cryptocurrency in a period from 2021 to 2023.

DISCUSSION
Bitcoin's daily returns in the 2021-2023 period showed high variability, reflected in extremes of -15,97 %

(low) and 18,75 % (high). Although the average daily return was positive (0,09 %), the negative median of -0,03 % reveals that more than half of the days presented losses. This duality between positive average growth and frequent daily losses highlights Bitcoin's highly volatile and speculative nature.

In terms of volatility, the observed spikes in daily returns are associated with significant market events. For example, in 2021, the launch of Coinbase Pro fueled a strong bullish trend in Bitcoin, while the subsequent correction, coupled with macroeconomic and regulatory events, led to steep fluctuations. The Russia-Ukraine war in 2022 introduced new sources of uncertainty, amplifying market volatility. In 2023, Bitcoin showed signs of recovery, with an annualized return of over 100 %, but again accompanied by periods of high volatility.

Analysis using GARCH models, particularly eGARCH, made it possible to estimate conditional volatility, confirming the ability of these models to capture the extreme asymmetries and shocks present in Bitcoin data. This result is consistent with previous studies, such as those by [13], which underscore the effectiveness of GARCH variants in modeling the volatility of highly speculative assets such as Bitcoin.

The estimated conditional volatility shows that daily returns were influenced by macroeconomic events, regulatory changes, and the internal dynamics of the cryptocurrency market. Periods of high volatility represent elevated risks, but also significant opportunities for investors with higher risk tolerances. On the contrary, periods of low volatility suggest relative stability, although they do not guarantee the absence of risks. The results confirm that Bitcoin, while profitable on average during the study period, represents a highly risky asset and sensitive to external events. This emphasizes the need for risk management strategies, such as diversification and the use of derivative instruments, to mitigate potential losses. In addition, traders and analysts should consider both historical trends and volatility projections to make informed decisions.

Finally, Bitcoin's variability, evidenced by volatility and extreme returns, is both an opportunity and a challenge. Its unpredictable nature reinforces the importance of advanced analytical tools and constant monitoring of external factors that could impact its future performance.

CONCLUSIONS

The study carried out on the behavior, profitability and volatility of the Bitcoin cryptocurrency has fulfilled the purpose of the research: to provide a solid basis for informed decision-making regarding the purchase, sale and investment in these assets. In addition, it has made it possible to identify and understand the risks associated with investing in Bitcoin. Volatility and calculated historical returns are key indicators for effectively modeling and managing financial risks. This analysis facilitates the creation of more informed investment strategies, understanding the behavior and performance patterns of these cryptocurrencies optimizes buying and selling decisions. Likewise, knowing how these assets behave is crucial to designing appropriate policies and regulatory frameworks for the cryptocurrency market. A thorough understanding of market volatility and dynamics is essential to protect investors and ensure market stability. In addition, understanding the behaviors and patterns of the cryptocurrency market is critical to fostering innovation and developing more efficient and secure solutions for trading and managing digital assets. This knowledge not only benefits investors and regulators, but also drives the evolution and maturity of the digital asset market, promoting a safer and more transparent environment for all market participants.

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CONFLICT OF INTEREST
The authors declare that there is no conflict of interest.

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