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Vladimir Tsenkov

Market Efficiency and Crypto Dynamics in a Downward Market Trend

Vladimir Tsenkov, PhD, is an Associate Professor at South-West University "Neofit Rilski", Faculty of Economics, Department of Finance and Accounting. His research interests are in the field of capital markets, market efficiency and risk management. Contact: v.tsenkov@yahoo.com

Abstract The study aims to analyze and distinguish the patterns of the volatility dynamics of Bitcoin and Bitcoin-based ETFs and that of established capital markets in the context of crisis market dynamics characterized by significant and persistent negative market trends. In order to investigate these the assumptions of the Efficient Markets Hypothesis are used and the measurement of market efficiency and the magnitude of impact of market shocks are carried out. By investigating the volatility characteristics of Bitcoin and its underlying ETF, the iShares Bitcoin Trust ETF (IBIT), on the one hand, and on the other hand, the established equity markets represented by the S&P 500 Market Index and the NASDAQ Composite Index, it is possible to achieve a characteristic distinction in the patterns of volatility dynamics in the context of a crisis and a pronounced downward market trend. The temporal aspect of the study covers two specific periods characterized by significant fluctuations in global capital markets, namely the global pandemic of COWID-19 and the intensification of protectionist sentiment in the United States following the election and inauguration of President Donald Trump's administration during his second presidential term in the period 2024-2025. The empirical results enable us to record the existence of hedging potential of the use of Bitcoin, and its underlying ETF, against established volatility dynamics of the capital markets. The pattern of volatility dynamics of Bitcoin between the two crisis periods studied shows a development that brings it closer to equity markets in the 2024-2025 period, but at the same time retains the hedging potential expressed by a significantly lower impact in a down market environment of the negative market information compared to equity markets. Bitcoin's hedging potential is demonstrated not only in terms of the volatility dynamics of the cryptocurrency itself, but also relative to the Bitcoin-based ETF, the iShares Bitcoin Trust ETF (IBIT).

Keywords Efficient Markets Hypothesis, Bitcoin, Market (Information) Efficiency, Market (Shocks) Impulses, Crisis Market Dynamics.

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Introduction

This study aims to analyze the patterns of volatility dynamics of the leading and most market capitalized cryptocurrency at the moment, Bitcoin, in the context of a direct comparison with the established capital markets represented by the leading indices S&P 500 and NASDAQ Composite Index. The comparison sought in the volatility dynamics model is made in the context of a specific market condition related to the presence of a persistent

downward market dynamic. In this way, a more specific view of the dynamics of cryptocurrency and capital markets would be achieved, going beyond generalized estimates of correlation formed on the basis of aggregated data obtained in the context of upward and downward trends. The sought specificity of the study focusing on persistent downward market trends is brought to the forefront by the understanding of the need to clearly distinguish the hedging properties of crypto assets vis-à-vis capital markets in a persistent downward market trend, i.e., an examination of how far crypto assets can be considered as an alternative investment opportunity in the face of market crises is pursued. In order to be able to highlight this hedging potential, two characteristic periods of study related to the downward market dynamics of the capital markets during the global pandemic of COBID-19 and the subsequent market turbulence after a few years around Donald Trump's second term as US President in the period 2024-2025 are used. The use of these two periods is made not only to achieve greater clarity on the patterns of volatility dynamics, but also to ascertain whether there is an evolution in their mechanism of action from one period to the other, i.e. from one crisis capital market to another. The inclusion in the study of a Bitcoin-derived asset such as the ETF - iShares Bitcoin Trust ETF (IBIT) is done in order to verify whether the assets in question directly replicate the pattern of volatility dynamics of the underlying asset on which they are constructed or add additional investment opportunities in general, and in particular in terms of their hedging potential against capital markets.

The empirical study aims to test the research hypothesis that in the context of crisis dynamics, crypto assets represented by Bitcoin and its derivative assets exhibit a different pattern of volatility dynamics allowing to form a hedging potential from their investment application. Using the conceptual toolkit of the Efficient Markets Hypothesis, the proof of the research hypothesis focuses on the analysis of the pattern of volatility dynamics determined by the level of achieved market (information) efficiency and the degree of influence of market shocks (impulses) and negative market news in the conditions of a sustained down market.

1. Relevant literature

The analysis of market volatility and the determinants of its dynamics is a topic directly related to the object of study of the Efficient Markets Hypothesis (EMH). Formulated by Fama (1970), it directly brings to the forefront the linkage between two factors: available market information and rational investment behavior. The interrelation between these two factors directly defines the weak form of the manifestation of EMH and predetermines the movement of market prices and the returns formed on their basis as a random walk process. A characteristic not only relevant to market returns in the presence of a weak form of EMH, but also expected from its volatility dynamics. It is in the context of market dynamics in crypto markets, and in particular that of the leading asset Bitcoin, that the question of market efficiency according to the EMH of these markets arises as a

determinant of the rationality of crypto volatility dynamics, and in particular the rationality of market price changes. Research on market efficiency in the context of the EMH of crypto markets provides evidence to support both of these extreme theses - the absence of (Al-Yahyaee, et al, 2018; Bundi & Wildi, 2019; Pappalardo, et al.,2018; Caporale, et al, 2018; Kristoufek, 2018) and the presence of market efficiency in the weakest form of EMH (Bartos,2015; Bariviera, 2017, Kumar, et al., 2020; Tiwari, et al., 2018, Nadarajah & Chu, 2017). We should also note the studies marking the existence of indications of an upward evolution in the development of market efficiency in cryptocurrency markets (Vidal-Tomás & Ibañez, 2018; Khuntia & Pattanayak, 2018; Wei, 2018; Sensoy, 2019; Selmi, et al.,2018; Yi, et al.,2023).

The question of the existence and extent of market efficiency in crypto asset trading markets takes on its own importance not only in the context of testing the assumptions of the EMH as a whole, but also throws its own challenges to the analysis of the determinants of market efficiency determined in the context of different market conjunctures. It is in this context that one can not only look for the characteristic behavior of the pattern of volatility dynamics of crypto assets, but also delineate the specific distinctions and opportunities for interaction with capital markets directly determined by the concreteness of upward or downward sustained market trends.

2. Econometric methodology used

From a methodological point of view, the econometric models used in the study imply an interpretation of volatility dynamics in the context of the market efficiency assumptions formulated in the Efficient Markets Hypothesis (EMH). The hypothesis assumes that, for informationally efficient markets, all information related to market dynamics is already reflected in the market price and any subsequent change in it is by definition unpredictable. As a consequence, the formation of persistent trends that carry over from one period to the next in both market returns and market volatility is unsustainable and of small amplitude of occurrence. The use of econometric GARCH-type models provides this direct opportunity to capture and quantify not only market efficiency but also the impact of established market trends by measuring indicators of *market (information) efficiency* and *the impact of market shocks*.

The data used in this study includes the daily values of Bitcoin, market indices (S&P 500 and NASDAQ Composite Index (COMP)), and the prices of a Bitcoin-based ETF - iShares Bitcoin Trust ETF (IBIT)). From the daily values used, a logarithmic return was calculated according to the following formula:

$$r_t = log\left(\frac{I_t}{I_{t-1}}\right), \text{ at lag 1} \quad (1)$$

Where I_t is the daily value (closing price) of the studied market indices and crypto assets at time lag t.

The time aspect of the study covers two specific periods characterised by significant fluctuations in global capital markets, namely the global pandemic of COBID-19 and the intensification of protectionist sentiment in the US following the election and inauguration of President Donald Trump's administration during his second presidential term:

- Period 1 - from 01.09.2020 to 31.06.2022;
- Period 2 - from 01.08.2024 to 30.04.2025.

The only exception to the above period split is made for the Bitcoin-based ETF - iShares Bitcoin Trust ETF (IBIT), which did not exist as of the first study period.

The following regression model of the returns from the studied market indices, ETFs and Bitcoin was used:

$$Y_t = C + \varphi_1 Y_{t-1} + \varepsilon_t \quad (2)$$

Where:

- C – regression constant;
- Y_{t-1} – returns from market indices, EFT and Bitcoin at lag t-1;
- φ_1 – regression coefficient.

In terms of volatility modeling, the exponential generalized autoregressive conditional heteroskedasticity model - EGARCH (P,Q) (Nelson, 1991) with a normal distribution and a Student's t distribution is used:

$$log\ h_t^2 = \alpha_0 + \sum_{i=1}^{P} \beta_i\ log\ h_{t-i}^2 + \sum_{j=1}^{Q} \alpha_j \left[\frac{|\varepsilon_{t-j}|}{h_{t-j}} - E\left\{ \frac{|\varepsilon_{t-j}|}{h_{t-j}} \right\} \right] + \sum_{j=1}^{Q} \gamma_j \left(\frac{\varepsilon_{t-j}}{h_{t-j}} \right) \quad (3)$$

Where:

$$E\{|z_{t-j}|\} = E\left(\frac{|\varepsilon_{t-j}|}{h_{t-j}} \right) = \sqrt{\frac{v-2}{\pi}} \frac{\Gamma\left(\frac{v-1}{2}\right)}{\Gamma\left(\frac{v}{2}\right)}$$

In degrees of freedom $v > 2$.

The choice of P and Q values for each EGARCH model used in the study was determined by testing different combinations of values and applying the Akaike Information Criteria (AIC) test. The initial combinations of the P and Q parameters were set to a maximum value of 2, thus the following combinations were tested: (1,1), (2,1), (1,2) and (2,2).

Market information efficiency as an indicator will be determined by the magnitude of the volatility persistence coefficient, representing the impact of prior period trends on volatility in the current period. In the asymmetric EGARCH (P, Q) model, the persistence coefficient is represented by the coefficient of - β_i. High values of this coefficient would imply low information efficiency, manifested in slower incorporation of market information due to the strong influence of past market volatility trends, and vice versa for lower values of the persistence coefficient. The definition of informational efficiency is consistent with the

assumptions of the Efficient Markets Hypothesis. The impact of market shocks on volatility will be measured by the value and magnitude of the EGARCH coefficient - α_j.

3. Empirical results

3.1. Selected models

Following the optimal dimensionality (P; Q) selection procedure applied EGARCH was performed the results of which are seen in Table 1. It is noteworthy that among the final selected models in terms of the data used the investigated crypto assets and equity market indices reach the highest dimensionality of (2;1), which indicates that in the conditions of crisis market dynamics the studied markets show restraint in establishing and following stable market trends related to their volatility. This observation, although on prima vista it may seem contradictory, given the downturns that have been observed, in fact marks the existence of markets that do not accelerate negative market trends, but follow them as far as the market conjuncture requires.

3.2. Market (information) efficiency

The study of information efficiency gives us insight into the extent of the market's incorporation of new information, which EMH assumes should be unpredictable in advance and its impact on market dynamics should be immediate and significant. This means that any new information impulse from the market should cause a reaction in market returns and volatility beyond established trends. In the context of the present study, high information efficiency implies that in periods of crisis-driven downward market dynamics, changes in the volatility of returns on the assets and markets under study should vary in two main directions. First, the change in volatility should only result from information that is new to the market, i.e., in a crisis down market, volatility should not follow the trend of previous periods, thereby actually accelerating it. The second, related to the manifestation of the so-called leverage effect expressed in the observed synchronicity of markets in the conditions of a downward market trend to provoke an increase in volatility and vice versa in positive market dynamics. Following the underlying logic of the EGARCH models, high market efficiency will be determined by the presence of low values of the coefficient of β_i thus, indicating a weaker impact of established trends in volatility over the impact of any new market information. Analyzing the data from the first period reflecting the crisis market during the COVID-19 pandemic, we should emphasize the characteristic behavior of Bitcoin compared to equity markets. The cryptocurrency demonstrates the highest degree of market (information) efficiency during this period - the β_i coefficient for BTC has a value of 0.906193 with the value of the same indicator for the S&P 500 and NASDAQ of 0.965151 and 0.951045, respectively. It is noteworthy, analyzing the level of market efficiency of the two capital markets, that they register relatively very similar values of their beta coefficients, which indicates the same degree of impact of the crisis on them, despite the fact that structurally the NASDAQ index is dominated by technology companies. The significant

difference in the level of informational efficiency during the COVID-19 pandemic of Bitcoin in comparison with the capital markets indicates not only the presence of market dynamics that do not allow the acceleration of the crisis market trend, but also the presence of market behavior different from that of the established capital markets, even that of the technology companies, of which the NASDAQ index is a representative.

Table 1. Results of applying the Akaike (AIC) information criteria test to the selected EGARCH models

Akaike Information Criterion for estimated model				
*For Bitcoin - **BTC-LR***				
Period 1	EGARCH (1,1)	EGARCH (1,2)	EGARCH (2,1)	EGARCH (2,2)
AIC	-3.650347	-3.644460	**-3.650770**	-3.649672
	EGARCH (2,1) – normal distribution		EGARCH (2,1)-Student's t distribution	
AIC	-3.650770		**-3.747403**	
Period 2	EGARCH (1,1)	EGARCH (1,2)	EGARCH (2,1)	EGARCH (2,2)
AIC	-4.379684	-4.394028	**-4.405082**	-4.388000
	EGARCH (2,1) – normal distribution		EGARCH (2,1)-Student's t distribution	
AIC	-4.405082		**-4.460467**	
*For iShares Bitcoin Trust ETF (IBIT) - **IBIT-LR***				
Period 2	EGARCH (1,1)	EGARCH (1,2)	EGARCH (2,1)	EGARCH (2,2)
AIC	-3.904008	-3.894550	**-3.904987**	-3.895376
	EGARCH (2,1) – normal distribution		EGARCH (2,1)-Student's t distribution	
AIC	-3.904987		**-3.907171**	
*For S&P 500 - **SP500-LR***				
Period 1	EGARCH (1,1)	EGARCH (1,2)	EGARCH (2,1)	EGARCH (2,2)
AIC	**-6.363294**	-6.340737	-6.359512	-6.351378
	EGARCH (1,1) – normal distribution		EGARCH (1,1)-Student's t distribution	
AIC	-6.363294		**-6.368937**	
Period 2	EGARCH (1,1)	EGARCH (1,2)	EGARCH (2,1)	EGARCH (2,2)
AIC	**-6.352522**	-6.272250	-6.281170	-6.269292
	EGARCH (1,1) – normal distribution		EGARCH (1,1)-Student's t distribution	
AIC	-6.352522		**-6.384117**	
*For NASDAQ Composite Index (COMP) - **NASDAQ-LR***				
Period 1	EGARCH (1,1)	EGARCH (1,2)	EGARCH (2,1)	EGARCH (2,2)
AIC	-5.778118	-5.778836	**-5.786977**	-5.783974
	EGARCH (2,1) – normal distribution		EGARCH (2,1)-Student's t distribution	
AIC	**-5.786977**		-5.783277	
Period 2	EGARCH (1,1)	EGARCH (1,2)	EGARCH (2,1)	EGARCH (2,2)
AIC	**-5.556969**	-5.538486	-5.553243	-5.544422
	EGARCH (1,1) – normal distribution		EGARCH (1,1)-Student's t distribution	
AIC	-5.556969		**-5.638615**	

Source: own calculations

The hedging potential of Bitcoin during the COVID-19 crisis undergoes its modification when considered in the context of the next period under study. For the period August 1, 2024 to April 30, 2025, Bitcoin's information efficiency shows a beta value identical to that of the equity markets - 0.931378 versus 0.937042 for the S&P 500 and 0.937042 for the NASDAQ. This indicates the existence of an *altered, modified, hedging potential of Bitcoin* in two ways. The first related to a change in the way negative market news is reflected (a

change in the gamma coefficient between the two study periods), the second related to the Bitcoin-based ETF, the iShares Bitcoin Trust ETF (IBIT). The ETF in question shows the highest level of market (information) efficiency, as its beta coefficient (0.770731) is significantly lower than the same indicator in equity markets - 0.937042 for the S&P 500 and 0.937042 for the NASDAQ. The difference between the beta coefficient values of the crypto ETFs and equity during the second study period is significantly higher than that between Bitcoin and equity markets during the COBID-19 pandemic. *This indicates not only that the hedging potential of the crypto asset during crisis times is maintained, but also that it is enhanced when hybrid instruments of the ETF type are used rather than the cryptocurrency on which they are based.*

Table 2. The empirical results of the EGARCH models used for Period 1 (from 01.09.2020 to 31.06.2022)

	EGARCH (p;q) model	*Distribution*	α_o *(P-value)*	α_1 *(P-value)*	α_2 *(P-value)*	$\alpha_1+\alpha_2$	γ *(P-value)*	β_1 *(P-value)*
BTC - P1	2,1	Student t	-0.736073 (0.0746)	0.057811 (0.5954)	0.134715 (0.2588)	0,192526	-0.046512 (0.2193)	0.906193 (0.0000)
S&P 500 - P1	1,1	Student t	-0.377902 (0.0005)	0.063509 (0.1450)	-	-	-0.238527 (0.0000)	0.965151 (0.0000)
NASDAQ - P1	2,1	Normal	-0.549454 (0.0000)	-0.142817 (0.2797)	0.298008 (0.0168)	0,298008	-0.203881 (0.0000)	0.951045 (0.0000)

Source: own calculations

Table 3. Empirical results of the EGARCH models used for period 2 (01.08.2024 to 30.04.2025)

	EGARCH (p;q) model	*Distribution*	α_o *(P-value)*	α_1 *(P-value)*	α_2 *(P-value)*	$\alpha_1+\alpha_2$	γ *(P-value)*	β_1 *(P-value)*
BTC - P2	2,1	Student t	-0.346535 (0.0033)	0.527552 (0.0007)	-0.743795 (0.0000)	-0,216243	-0.075203 (0.0158)	0.931378 (0.0000)
IBIT - P2	2,1	Student t	-1.556930 (0.0509)	-0.204687 (0.3593)	0.182984 (0.4217)	-0,021703	-0.165951 (0.0929)	0.770731 (0.0000)
S&P 500 - P2	1,1	Student t	-0.413551 (0.0000)	-0.244728 (0.0001)	-	-0.244728	-0.441374 (0.0000)	0.937042 (0.0000)
NASDAQ - P2	1,1	Student t	-0.352845 (0.0042)	-0.174319 (0.0276)	-	-0.174319	-0.392177 (0.0000)	0.948217 (0.0000)

Source: own calculations

3.3. Impact of market shocks

After measuring the level of market (information) efficiency, the next relevant question is that of distinguishing the factors determining the dynamics of volatility of the studied indices and Bitcoin. One of the first questions in this regard is that of the strength of the impact on volatility by market shocks associated with the daily market presentation of relevant and significant information (news) that directly affects the market return dynamics and volatility of the studied markets and cryptocurrency.

Analyzing the impact of market shocks expressed by the value of the statistically significant coefficients alpha of the EGARCH models used, it should be noted that for the crisis Period 1 associated with the impact of the COWID-19 pandemic, the only statistically significant coefficient is registered for the NASDAQ model (0.298008), which indicates that market shocks are responsible for approximately 30% of the change in its volatility in the period considered. The impact of this indicator during subsequent examined period shows opposite pattern of impact. During Period 2, the value of NASDAQ's coefficient alpha (-0.174319) is negative and lower compared to Period 1, which when analyzed in the context of relatively identical levels of information (market) efficiency for both periods, indicates that during the second study period, the impact of market shocks is weaker and reduces the deviation of volatility from the established trend. Analyzing the impact of market shocks on Bitcoin volatility, we should note that during Period 2 it is very close in value and identical in sign to that of equity markets - a value of -0.216243 for Bitcoin, -0.244728 for the S&P 500 and -0.174319 for the NASDAQ. Adding to the above that the level of informational (market) efficiency of Bitcoin and capital markets, as measured by beta coefficients, is nearly identical we could infer the existence of a change in the determinants of the crisis dynamics of Bitcoin volatility between the two periods of market crisis turbulence of 2020 and 2024/25.

Namely, Bitcoin volatility in the second study period compared to the first is more likely to follow an established market trend, in sync with the same propensity of established equity markets, at an identical level of response to market shocks as equity markets, but the significant difference comes from the way negative market news is reflected, as measured by the value of the gamma coefficient. For Bitcoin, the value of this coefficient is (-0.075203) is 6 times lower than the value of the same indicator for the S&P 500 (-0.441374) and 5.5 times lower compared to what is recorded for the NASDAQ (-0.392177). *This shows that although the dynamics of Bitcoin volatility between the two periods of study is evolving, bringing it closer to that of the established capital markets as a pattern of behavior, at the same time Bitcoin volatility retains this property in the conditions of crisis and downward market trend to take into account negative market information (news) to a significantly lower extent and therefore this information provokes a smaller increase in volatility and does not lead to its further acceleration.* We find the latter to be important when considering the hedging potential of Bitcoin against established equity markets in the face of negative crisis market dynamics.

Conclusions

1. In a downward market trend associated with the presence of a persistent negative crisis impact, Bitcoin and its underlying ETF, the iShares Bitcoin Trust ETF (IBIT), exhibit different volatility dynamics compared to the pattern demonstrated by the equity markets represented by the S&P 500 and NASDAQ Composite Index (COMP).

2. The significantly higher level of market (informational) efficiency during the COVID-19 pandemic of Bitcoin compared to the capital markets under study indicates not only market dynamics that do not allow the acceleration of the crisis market trend, but also the presence of market behavior different from that of established capital markets.

3. The dynamics of Bitcoin's volatility between the two periods of the study is evolving, bringing it closer as a pattern of behavior to that of the established capital markets, but at the same time, Bitcoin's volatility retains its property in the conditions of crisis and downward market trend to take into account negative market information (news) to a significantly lower extent and therefore this information provokes a smaller increase in volatility and does not lead to its further acceleration.

4. Bitcoin and the ETFs based on it are a good hedging opportunity for the traditional capital markets in a crisis and a strong downward market trend. During these periods, the volatility dynamics of the cryptocurrency is not only more efficient in the context of the Efficient Markets Hypothesis (it is less affected by the established market trend), but the impact of negative market information compared to equity markets is many times lower on Bitcoin's volatility.

5. The hedging potential of Bitcoin is demonstrated not only in terms of the volatility dynamics of the cryptocurrency itself, but also in terms of the Bitcoin-based ETF - iShares Bitcoin Trust ETF (IBIT). IBIT's recorded highest degree of market (information) efficiency over the 2024/25 study period indicates not only that the hedging potential during a crypto asset crisis is maintained, but also that it is enhanced when hybrid instruments of the ETF type are used versus standalone use of the cryptocurrencies on which they are based.

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