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Coronavirus Spreads and Bitcoin's 2020 Rally: Is There a Link?

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Abstract: *The coronavirus epidemic is not the first virus outbreak that has threatened to disturb financial markets. But the world is now more interconnected since the 2003 SARS outbreak as global companies' revenues have become much more exposed to China. The purposes of this paper are threefold. The first is to address the timely question of whether Bitcoin exhibits a safe-haven property against heightened uncertainty over how the duration and spread of the coronavirus could hit the world economy. The second purpose is to assess if the initial news of the coronavirus outbreak have led to an increased volatility of Bitcoin. The third aim is to test if Bitcoin immediately react on publicly announced information (follows the hypothesis of efficient markets). We show that the current bullish sentiment is triggered by investors seeking Bitcoin as a safe haven in the uncertain times ahead. But we also find that the virus intensifies the volatility of Bitcoin due to a search by investors for alternative asset classes amid concerns about the coronavirus. The information regarding the coronavirus takes time to be reflected in the Bitcoin price, highlighting the associated inefficiencies it brings. Also, the risk to global markets may currently be masked owing to wide liquidity injections by Central Banks including the People's Bank of China and the U.S Federal Reserve.*

Keywords: *Coronavirus, Bitcoin, Safe haven, Volatility, Efficiency.*

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I. Introduction

The coronavirus outbreak that started in the Chinese city of Wuhan has spread promptly across the country and beyond its borders, leaving governments scrambling to mitigate person-to-person transmission of the virus. As with several crises, the repercussion of the coronavirus can also be felt in the global economy as well as the financial markets. Many analysts compare the coronavirus to the 2003 SARS. Even though this can offer useful information, there are sharp dissimilarities between the two periods to account for. China has currently a much larger part of the global economy and markets than it was 17 years ago. According to World Bank statistics, China's share of global trade increased to appromximately 14% in 2019 compared to 5% in 2003. Furthermore, its share of the MSCI Emerging Markets Index has risen to almost 35% in 2019 from 8% in 2003.

The history suggests that when a disease outbreak happens, it will rapidly be contained. The economic consequences will be relatively moderate and the equities will be modestly affected. For instance, the SARS virus occuring in China in 2003 and killed 774 people, but it was contained and the stock market increased by more than 20 percent that year. However, things are likely to be much different with the coronavirus. The global economy seems very fragile and an extended disease outbreak might tip the contemporanuous aging business cycle into a global recession. This outbreak exacerbates the uncertainty surrounding the global economic outlook. The coronavirus remains spreading promptly and has attained over 25 countries as of February 15, 2020. Coronavirus cases in China overtake SARS and the impact could be more severe.The risk to investors may be much more pronounced (see Figure A1, Appendix). We can dig profoundly to understand the economic exposure of disaggregated equities and stock portfolios to China's economy, based on sources of firms' revenues. Using the MSCI Economic Exposure database, Figure A1 depicts that the several developed stock markets were largely vulnerable to coronavirus, with large extent Singapore, Hong Kong, Taiwan, Australia and Korea. The impact of the virus on markets and, ultimately, on global growth depends largely on the duration and spread of the outbreak as well as policy responses

by the Chinese authorities (i.e., how well China can ultimately contain the outbreak) and other international organizations including the World Health Organization (WHO). There is a beginning of anxiety on the financial markets because of the development of virus. If a remedy is not found promptly, the panic can affect the global market. This seems highly expected especially with the information coming from China at the end of January 2020 which is not reassuring. Indeed, we learn that real estate sales fall by more than 80% in February and car sales by about 92% which is simply 'never seen'.

As the global stock markets fell against the fears of a Coronavirus outbreak, it is highly expected that investors will look at so-called safe-haven. The Bitcoin price has witnessed a rapid upward evolution from 23 January to 9 February 2020. It must be pointed out at this stage that the Bitcoin price has not experienced such a marked increase for almost 3 months. In this context, Bitcoin can act as a safe haven asset. Even though there may be various important factors driving it, one can't overlook the emergence of Coronavirus as a determining factor. Throughout our analysis, we will try to answer if the new deadly virus that has infected more than 80,234 people[2] as of February 24, 2020, mostly in mainland China, responsible for the recent increase of Bitcoin price.

Over the last few years, the ability of Bitcoin to act as a safe haven, hedging and diversifier has been largely assessed by academics while looking into its correlation with different assets and commodities. Bitcoin -which lives outside the confines of a single country's politics- gained largely from the contemporaneous global uncertainty and the loss of faith in the stability of banking system. Accordingly, Dyhberg (2015) argued that Bitcoin possesses hedging characteristics and can be included in a portfolio to curtail the adverse impacts of possible risks. Baur et al. (2015) assessed the statistical properties of Bitcoin and found an insignificant correlation between the Bitcoin and stocks, bonds and commodities in normal times and in periods of financial turmoil. Besides, Bouoiyour and Selmi (2017) analyzed whether Bitcoin could serve as a hedge and an investment safe haven for the U.S. stock market, showing that the role of Bitcoin as a hedge and a safe-haven is time varying. Further, Bouri et al. (2017) evaluated the role of Bitcoin as a diversifier, a hedge, or a safe haven for movements in energy commodities and non-energy commodities. They deduced that Bitcoin can act as an effective diversifier, hedge and a safe-haven against movements in energy commodity indices, but not for non-energy commodities. Interestingly, Luther and Salter (2017) indicated that the attention towards Bitcoin rose remarkably following the announcement that Cyprus would accept a bailout on March 16, 2013. Bitcoin has also been reported in countries such as Greece,when debt talks with IMF enter dramatic phase (June 24-30, 2015). It has been largely documented that Bitcoin tends to be resilient during market crashes as it isnegatively dependent on risky assets (see inter alia, Baur et al. 2015 ; Bouri et al. 2017 ; Bouoiyour and Selmi 2017). If risky assets collapse, worries increase, and investors typically seek out the safe haven features of gold and Bitcoin. Bitcoin is generally chosen as an attractive investment. It is extremely volatile and its speculative behavior enables investors and traders to earn supernormal returns in a short-time span. Despite the Bitcoin's climb in response to specific crises and events highlights a confidence in Bitcoin as a safe haven, hedge and an alternative currency, experts are still reluctant to give this volatile virtual currency such status. Investors and traders are generally interested in hedges that mitigate the volatility of their portfolio, but also they are likely interested in buying some sort of insurance against extreme tail events (Selmi et al. 2018).

Much significant research has been conducted to investigate the responses of Bitcoin to uncertainty over different events including the Grexit, the Brexit, the oil market crash (see inter alia, Luther and Salter 2017; Selmi et al. 2018; Bouoiyour and Selmi 2019 a, b). But what differentiates the present research from prior studies is its originality that we can grasp through our three main purposes. First, our study examines whether the recent increase of Bitcoin price[3] is mainly due to the emergence of coronavirus outbreak (January 2020). In other words, we test whether increasing anxiety over this virus has consolidated the position of Bitcoin as a safe haven asset. Second, we ask the question of concordance between two notions which may a priori seem contradictory. We should keep in mind that Bitcoin has been largely served as a safe haven regardless of its speculative attitude and excessive volatility. These two notions are in principle contradictory.This unsual behavior of Bitcoin lead us to ask a third question relative to its efficiency. We have strong doubts over the efficiency of this cryptocurrency widely (but not entirely) attributed to its great volatility. In other words, we assess if the price of Bitcoin follows the hypothesis of efficient markets (Fama, 1970). Efficient markets are when, in any given time, the prices on the market already reflect all known information and change fast to reflect new information.

This paper is the first, to our best knowledge, to conduct an event study methodology to examine the abnormal returns[4] behaviors for Bitcoin since Wuhan was placed under quarantine on January 23, 2020. An event study methodology looks at the sharp changes in the Bitcoin prices following this unforseen event. According to the modern financial theory, the price of an asset accounts for all available information and expectations about the future. For empirical purpose, we carry out a dynamic event-study. A huge number of studies have argued that the traditional event study methodology exhibits a bias toward detecting "event effects", irrespective of whether such effects actually occur (for example, Ramiah et al. 2016 ; Pham et al. 2018). To avoid possible econometric pitfalls, this study uses a flexible approach that controls for stochastic behaviors of the markets which are assumed away by the standard event study methodology. More particularly, we use a dynamic event-study method which allows one to simultaneously include the time-varying systematic risk, the conditional heteroskedasticity and the leverage effect in the calculation of returns over the estimation period. Instead of residuals utilized in the traditional event-study approach, excess returns are determined via the standardized one-step-ahead forecast errors using the Kalman filter tool. A portmanteau test is applied to assess if the cumulative abnormal returns (CAR) are distinct from zero. This test enables a longer event window with no necessity to precise the timing of the event. Besides, unlike the standard event study methodology, a graph of the CAR can offer more proper indication regarding the point at which the market starts to react to the event. This is an important contribution for the crypto or Bitcoin currency, where the information gradually diffuses into the market. We show that Bitcoin prices react positively to cornavirus epidemic, reinforcing the status of Bitcoin as a digital gold or a safe haven. But when we account for the major features of financial time series including the time-varying beta, the autocorrelated squared returns, and the fat-tailed property of daily return data, we deduce that the Bitcoin price becomes too volatile to be considered as a store of value. Moreover, the adjustment of Bitcoin prices is inconsistent with the assumption of the efficient market hypothesis. Overall, our results confirm that Bitcoin remains far from being closer to efficiency, and we explain this by its speculative and volatile behavior. Overall, we robustly deduce that regardless of its extreme volatility and inefficiency, Bitcoin keeps its status as a safe haven during turbulent times. We can, therefore, consider Bitcoin as a crypto safe haven. Such information have relevant implications for investment decisions, portfolio allocation, the pricing of derivative securities and risk management in the current uncertain times.

The rest of the paper is organized as follows. Section 2 presents some basic insights into the event study methodology procedure. Section 3 reports the main findings whith respect to the different features of Bitcoin (i.e., safe haven, volatility and efficiency) in times of uncertainty surrounding coronavirus spreads. Section 4 discusses the results and concludes.

II. Empirical Strategy And Data

Since the Efficient Market Hypothesis (EMH) has emerged (Fama, 1965, 1970), it has been subject to a number of empirical works. Under the assumption of rational investor, this hypothesis claims that asset prices completely reflect information and expectations, and that any new information is included into asset prices promptly. If Bitcoin follows the EMH hypothesis, its prices would adjust with the emergence of sudden event, but these price adjustments would become less pronounced after the announcement day (post-event period). To test the assumption of efficiency for the Bitcoin market, we examine the response of the Bitcoin price to coronavirus. We consider the day when Wuhan was placed under quarantine on January 23, 2020 as the announcement day of this event. In addition, we cater for potential control variables going from the least-to-most potential Bitcoin determinants across fundamental, macroeconomic and financial determinants. Specifically, we consider the velocity of bitcoins in circulation (*VC*); the exchange –trade ratio (*ETR*); the gold price (*GP*); speculative factors (i.e., the increased interest in Bitcoin) and technical drivers (the hash rate, *HR*). We collected daily time series data covering the period from January 01, 2018 to February 15, 2020. The Bitcoin price index (*BPI*) is an index of the exchange rate between the US dollar (USD) and the Bitcoin (BTC). The CoinDesk Bitcoin Price Index represents an average of Bitcoin prices across leading bitcoin exchanges. The total number of Bitcoins in circulation is given by a known algorithm until it reaches 21 million bitcoins. As a measure of the transactions use, we employ the ratio between trade and exchange transaction volume or the ratio between the volumes on the currency exchange markets and in trade (i.e. *ETR*). To measure the speculative attitude of Bitcoins, we use the daily views from Google Trends (*GTR*) by searching the term "Bitcoin" as a proxy of the attention towards Bitcoin. Besides, the creation of new bitcoins is mainly determined by the difficulty that mirrors the computational power of Bitcoin miners (or the hash rate, *HR*). Table A1 summarizes all the data used and their sources.

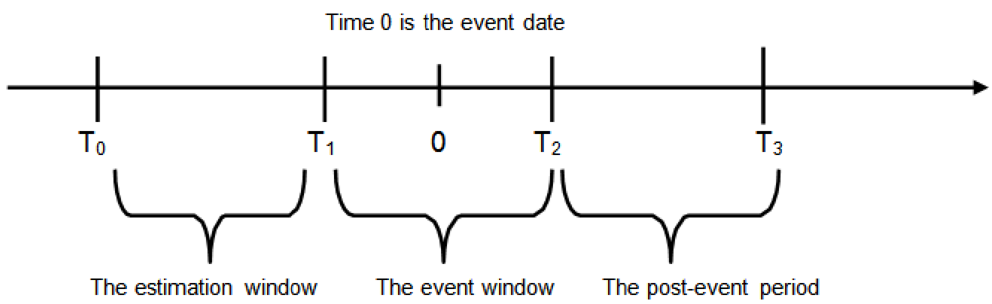
This study applies a time series regression with a generalized autoregressive conditionally heteroskedastic (GARCH) effect market model. This specification allows one to examine the abnormal returns of the Bitcoin price in response to the start of coronavirus, while accounting for some characteristics of market models for Bitcoin prices (i.e., stochastic, time varying non-diversifiable risk and a time varying heteroskedastic error structure, Brockett et al. 1999).This dynamic event study is carried out based on the cumulative sums of standardized one-step-ahead forecast errors that is based on a GARCH error market model in order to effectively capture how and to what extent a particular event exerts an impact on the market.

The standard market model (cumulative abnormal returns)

We use the standard market model event study methodology as depicted by Dodd and Warner (1983) and Brown and Warner (1985) to do the analysis. The conducted empirical strategy has been successfully applied to a large variety of events (Benninga, 2008). A common concern is that the event under consideration is rarely an unanticipated occurrence. Often, news about corporate events is publicly announced prior to their taking place. Differently, we are interested throughout this study in the Bitcoin price reaction that occurs immediately after regulatory decisions are made public. Due to the exogenous nature of these decisions, this assessment does not suffer from the problem of partial anticipation that may plague event studies. However, we should be cautious and acknowledge the possible occurrence of idiosyncratic effects.

We define day "0" as the announcement day of the regulatory decision regarding Bitcoin. Then, the estimation and event windows can be determined (Figure 1). The interval T0-T1is the estimation window which provides the information needed to specify the normal return (i.e., prior to the occurrence of the event). The interval T2-T1+1 is the event window, and the interval T3-T2 is the post event window which is used to investigate the behavior of the Bitcoin market following the event. The length of the event window often depends on the ability to accurately date the announcement date. If one is able to date it precisely, the event window will be less lengthy, and thus capturing the abnormal returns will be more appropriate. We consider a window of 260 days[5], consisting of 239 days before the event day and 20 days after the event as well as the event day.

Figure 1. Data structure of an event study



Based on the selected return model, event studies consist generally of applying an event window only (e.g., the market-adjusted model) or an event and an estimation window (e.g., the market model) to the sample data. The market model is the most commonly used model in the literature. It predicts normal returns with a regression investigation that in this study regresses the Bitcoin (BTC) returns on the crypto market returns over the estimation window. Through this assessment, the relationship between Bitcoin and its benchmark index

(CRIX[6]) is captured by the two parameters (α and β) depicted in Equation (1). Figure 1

sketches the data structure used by the event studies and offers information on how this data structure is employed by the market model. Based on Figure 1, the cumulative abnormal returns (CAR) can be defined as the difference made up by the Bitcoin returns during the event window minus the return expected based on its past performance, as compared to the returns of the market over the estimation window. The CAR for the Bitcoin market during the event window $[\tau_1;\tau_2]$ where $[\tau_1;\tau_2] = \in [0; +20]$ and is expressed as follows:

$$CAR_{[\tau_1,\tau_2]} = \sum_{t=\tau_1} (R_t - \alpha - \beta R_{M,t}) \quad (1)$$

Where

$CAR_{[\tau_1,\tau_2]}$ is the cumulative abnormal return of the Bitcoin price during the event window $[\tau_1; \tau_2]$, $R_{i,t}$ is the realized return of Bitcoin on day t[7], $R_{M,t}$ is the return of the benchmark index of the crypto market, α and β are the regression estimates from the ordinary least squares (OLS) regression in Equation (1).

The dynamic market model (cumulative abnormal volatility)

In principle, the $\hat{\beta}$ term may be modeled by any ARMA (p, q) process. Nevertheless, the majority of empirical studies reveal that an AR(1) process is sufficient. Accordingly, we extend the single index market model to a time varying coefficient regression (TVCR) model, which can be denoted as:

$$CAR_{[\tau_1,\tau_2]} = \sum_{t=\tau_1}^{\tau_2} (R_t - \alpha$$

where $\beta_t - \beta = \bar{\phi}(\beta_{t-1} - \beta) + \bar{\alpha}_t$

ϕ is the backshift operator.

We then conduct the market model to reflect the heteroskedastic behavior of the error variance over time. Even though most standard event study methods propose a constant variance through the pre-and post-event windows, some researchers including Brown and Warner (1985) have argued that if the variance is underestimated, the test statistic will prompt a rejection of the null hypothesis. Also, some studies such as Schwert and Seguin (1990) have examined the prominence of adjusting for autoregressive conditionally heteroskedastic (ARCH) effects in the residuals derived from the standard market models. It is shown that the ability to reliably form statistical inferences can be compromised by failing to account for the

ARCH error structure. Because the volatility clustering and leptokurtosis are commonly observed in economic and financial time series, we consider this in our model by performing the generalized autoregressive conditionally heteroskedastic GARCH (1, 1) to the error or residual term.

The GARCH (General Autoregressive Conditional Heteroskedasticity)-type modeling has been and continues to be a very valuable tool in finance and economics since the seminal paper of Engle (1982). Engle (1982) proposes to model the time-varying conditional variance with Auto-Regressive Conditional Heteroskedasticity (ARCH) processes using lagged disturbances. Further, Engle (1982) argues that a high ARCH order is required to properly capture the dynamic behavior of the conditional variance. The Generalized ARCH (GARCH) model of Bollerslev (1986) fulfills this requirement. However, one of the most important limitations of standard GARCH models is that they are unable to capture the stylized fact that conditional variance tends to be stronger after a decrease in return than after an increase.

To control for this bias, many alternative models that account for asymmetry have been proposed including the Exponential- GARCH introduced by Nelson (1991). This model specifies the conditional variance in logarithmic form denoted as:

$$\log(\sigma_t^2) = \omega + \sum_{i=1}^{q} (\alpha_i z_{t-i} + \gamma_i (|z_{t-i}| - \sqrt{2/\pi})) + \sum_{j=1}^{p} \beta_j \log(\sigma_{t-j}^2) \quad (3)$$

where ω, α_i , β_j , γ and zt are the parameters to estimate (the reaction of conditional variance, the ARCH effect, the GARCH effect, the leverage effect and the standardized value of error, respectively).

After determining the cumulative abnormal returns using the Exponential-GARCH model (CAV), we investigate whether the Bitcoin market's reaction to the start of coronavirus depends on potential Bitcoin fundamentals. An investigation of responses of Bitcoin's abnormal volatility (CAV) to the announcement of regulatory decisions in different countries is then undertaken. The regression to be estimated is expressed as follows:

$$CAV_{i,[\tau_1,\tau_2]} = \delta_0 + \delta_1 Coronavirus + \delta_2 VC + \delta_3 ETR + \delta_4 GP + \delta_5 GTR + \delta_6 HR + \varepsilon_t \quad (4)$$

where $CAR_{[\tau_1,\tau_2]}$ is the dependent variable, *Coronavirus* is a dummy variable which takes the

value of one on the first day of trading after Wuhan was placed under quarantine on January 23, 2020, and zero otherwise.

Once the model is specified by the data from the estimation period, the Kalman filter can be utilized to generate the one-step-ahead forecast errors, or innovations, for the post- sample (event period) data. By the standardized one-step-ahead forecast errors, we mean:

$$z_l = \frac{v_l}{\sqrt{f_l}} \text{ where } l \in \text{ event period} \qquad (5)$$

.

III. Results and discussion

The standard market model (cumulative abnormal returns)

Table 1 reports the standard market model results. We find that the Bitcoin returns do not respond immediately to coronavirus (i.e., insignificant for both the [0; 0] and [+1; +10] window events. activities around the world. Interestingly, the Bitcoin market experienced a positive abnormal return of 9% after 20 days of the announcement of coronavirus. But it isn't the only factor helping to push the Bitcoin higher. We also find that the recent bitcoin rally can be due to heightened global economic uncertainty consisting of increasing worries over U.S.- China war, U.S.-Iran tensions, Brexit concerns as well as tensions between Japan and South Korea. All these factors have boosted markedly Bitcoin prices. But the coronavirus is clearly the most important catalyst as of late. It must be pointed out that the economic impact of the coronavirus if more outbreaks happens outside of China, could be the stimulus of not just declining stock markets but also a global downturn. We shouldn't overlook that China is the second largest economy in the world. Bitcoin tends to do well in periods of economic uncertainty and geopolitical risks. Fears are now surfacing about the impact on Chinese economic growth, while global signals also suggest investors are more cautious about the short-term. There's another potential reason the Bitcoin price may be increasing as the new virus spreads. This is due to that fact that 65 percent of Bitcoin mining takes place in China. As workforces are quarantined and global trade is declining, that implies two things: fewer Bitcoin miners are available to work, and less mining equipment is coming out of China. More accurately, Coronavirus exerts a significant influence on mining activity, which may thereafter be driving up the Bitcoin price.

Our results also reveal that the monetary velocity of bitcoins in circulation exerts a negative impact on the Bitcoin price. This outcome is in line with the quantity theory, assuming the evidence that the price of Bitcoin decreases with the stock of bitcoins. The Bitcoin money supply works as a standard supply so that its increase leads to a price decrease. In addition, we note that the exchange-trade ratio is positively and strongly correlated with the price of Bitcoin. The usage of Bitcoin in real transactions (purchases, services, etc.) is significantly connected to the fundamental aspects of its value. Theoretically, the price of the currency should be positively related to its usage for transactions, as it raises the utility of holding the currency leading to an increase in its prices. Bitcoin and gold do not evolve in the same direction. As the two assets are viewed as a hedge and a safe haven in turbulence times, we can indicate that one causes the other, but the factors driving the price of Bitcoin and the price of gold may be different (Bouoiyour and Selmi, 2017).Our findings also indicate a negative effect of the hash rate on the Bitcoin price. The higher number of miners that join the Bitcoin network, the more important the network hash rate is. Mining can be perceived as a kind of investment towards Bitcoin (Ciaian et al., 2016). A strong hash rate connected with growing cost demands for hardware and electricity pushes miners to the mining pool. If these miners employ the coins as an alternative to the direct investment, they can turn to Bitcoin purchasers

and thus amplify the demand for Bitcoin, thereby raising its prices. We also show that an increased attention to Bitcoin (GTR) is accompanied with a rise in the Bitcoin prices.

Table 1. The impact of coronavirus on Bitcoin's cumulative abnormal returns

	CAR(0)	CAR(5)	CAR(10)	CAR(20)
Constant	6.1578**	5.1467***	5.1789**	7.0316*
	(0.0045)	(0.0009)	(0.0000)	(0.0324)
Coronavirus	**0.06521**	**-0.0089**	**0.0735**	**0.1538****
	(0.1215)	**(0.3110)**	**(0.1269)**	**(0.0071)**
	-0.1345**	-0.1088*	-0.0339***	-0.0211**
MV	(0.0054)	(0.0640)	(0.0003)	(0.0043)
	0.1598**	0.1843**	0.1018*	0.1212*
ETR	(0.0082)	(0.0074)	(0.0202)	(0.0313)
	-0.0034***	-0.0019*	-0.0029***	-0.0031**
GP	(0.0004)	(0.0115)	(0.0007)	(0.0011)
	0.1432*	0.0548*	0.1239**	0.0135

GTR	(0.0308)	(0.0216)	(0.0056)	(0.5703)
	-0.0934**	0.0137*	-0.0312*	-0.0345**
HR	(0.0041)	(0.0343)	(0.0611)	(0.0479)
Adjusted R^2	0.72	0.66	0.69	0.78
F-value	3.7245	3.1862	4.0986	3.6145

Notes: All regressions are controlled for heteroskedasticity, and the p-values are given in parentheses. ∗, ∗∗, ∗∗∗
denote statistical significance at the 10%, 5% and 1% levels, respectively.

The dynamic market model (cumulative abnormal volatility)

This study contributes to the event studies literature by conducting a stochastically flexible event-study methodology to examine the reaction of the conditional variance or more precisely the abnormal volatility of the Bitcoin price to the new deadly virus. Precisely, we adopt a new procedure of calculating the cumulative abnormal returns by taking into account certain known characteristics of financial time series including the time-varying beta, the autocorrelated squared returns, and the fat-tailed property of daily return data. An autoregressive process with order 1, AR(1) is initialized for β, and an Exponential-GARCH(1,1) process is utilized to model the time-varying conditional variance while accounting for asymmetry. Our results reported in Table 2 reveal that the ARCH effects, betas and the
leverage effects are present in our sample. We also clearly show that the volatility of Bitcoin seems persistent (the duration of persistence ($\alpha + \beta + 0.5\ \gamma$) is equal to 0.68) over the period
under study, and that its prices reacts more strongly to negative news (a positive and significant leverage effects (γ)).

Table 2. Exponential-GARCH parameters

Dependent variable: (r_t)	
Mean equation	
C	0.0561*** (0.0003)
r_{t-1}	-0.1472*** (0.0000)
Variance equation	
ω	0.1678** (0.1875)
α	0.3819* (0.0061)
β	0.2562** (0.0043)
γ	0.1149* (0.0106)

Notes: ω is the reaction of conditional variance; α is the ARCH effect; β is the GARCH effect; γ is the leverage
effect; *r* is the return of the Bitcoin price index; *, **, *** denote significance levels of 10%, 5%, 1%, respectively.

By controlling for the time-varying beta, the autocorrelated squared returns, and the leverage effects and the fat-tailed property of the Bitcoin return data (see Table 3), we find that the coronavirus exacerbates the volatility of Bitcoin prices. As the time passes (after twenty days, the impact of coronavirus on the price of Bitcoin becomes more severe. This is inconsistent with the efficient market hypothesis, assuming that the price adjustments become less severe after the occurrence of unforeseen event. This means that the volatility of Bitcoin is extremely linked to its inefficiency.

Concerning the additional control variables, we often show that the use of Bitcoin in trade and speculation (proxied by the investors' attractiveness towards Bitcoin) are the most potential driving forces of Bitcoin price changes. The velocity of bitcoins in circulation, the gold price and the hash rate were found to be the fundamentals that negatively affect the Bitcoin price variation.

Table 3. The impact of coronavirus on Bitcoin cumulative abnormal volatility

	CAV(0)	CAV(5)	CAV(10)	CAV(20)
Constant	3.6145**	2.7123**	4.2168**	3.7251*
	(0.0017)	(0.0049)	(0.0052)	(0.0104)
Coronavirus	**0.0914**	**0.0001***	**0.15673****	**0.1921****
	(0.1389)	**(0.0417)**	**(0.0058)**	**(0.0010)**
VC	-0.1368***	-0.1415*	-0.1294**	-0.1258**
	(0.0000)	(0.0132)	(0.0034)	(0.0025)
ETR	0.1195***	0.14521**	0.1261**	0.1280**
	(0.0004)	(0.0032)	(0.0013)	(0.0011)
GP	-0.0019***	-0.00128**	-0.0065**	-0.0083**
	(0.0006)	(0.0011)	(0.0034)	(0.0017)
GTR	0.1025**	0.13452**	0.1410*	0.1134**
	(0.0052)	(0.0038)	(0.0121)	(0.0089)
HR	-0.0012***	-0.00234*	-0.0013**	-0.0012**
	(0.0000)	(0.0010)	(0.0012)	(0.0028)
Adjusted R^2	0.84	0.76	0.84	0.86
F-value	4.1376	4.2156	4.2209	4.3855

Notes: All regressions are controlled for heteroskedasticity, and the p-values are given in parentheses. ∗, ∗∗, ∗∗∗
denote statistical significance at the 10%, 5% and 1% levels, respectively.

Sensitivity tests
Multiple tests have been conducted to check the consistency of the obtained results.
Cumulative abnormal returns

a) Different event window
By considering a restricted event window of 120 days, our main findings reported in Table 4 confirm that the Bitcoin returns do not react immediately to coronavirus. But after 20 days of the start of Coronavirus, Bitcoin witnessed a marked increase of the abnormal returns, underscoring its role as a safe haven regardless of its inefficiency reflected by the delayed response to coronavirus. The coefficients associated to the explanatory variables are also still fairly robust in terms of sign and significance despite some slight changes.

Table 4. The impact of coronavirus on Bitcoin's cumulative abnormal returns: Different window (120 days)

	CAR(0)	CAR(5)	CAR(10)	CAR(20)
Constant	4.3215***	3.9234**	4.6982***	5.1043**
	(0.0003)	(0.0011)	(0.0005)	(0.0018)
Coronavirus	**0.0982**	**0.0547**	**0.1019**	**0.1271*****
	(0.3214)	**(0.6248)**	**(0.1042)**	**(0.0008)**
MV	-0.1182***	-0.0872**	-0.0871**	-0.0405**
	(0.0000)	(0.0091)	(0.0049)	(0.0061)
ETR	0.1124***	0.1567**	0.1652***	0.1438**
	(0.0009)	(0.0041)	(0.0003)	(0.0051)
GP	-0.0010**	-0.0012***	-0.0016**	-0.0024***
	(0.0052)	(0.0007)	(0.0053)	(0.0006)
GTR	0.0921**	0.0310**	0.1349***	0.0714*
	(0.0098)	(0.0041)	(0.0004)	(0.0891)
HR	-0.0612***	-0.0555***	-0.0781**	-0.0617***

	(0.0008)	(0.0001)	(0.0097)	(0.0005)
Adjusted R^2	0.79	0.81	0.78	0.77
F-value	4.2156	4.1927	4.0032	3.9178

Notes: All regressions are controlled for heteroskedasticity, and the p-values are given in parentheses. $*$, $**$, $***$
denote statistical significance at the 10%, 5% and 1% levels, respectively.

b) Further control variables

We examine the impact of coronavirus to abnormal Bitcoin returns while using Wikipedia as a measure of the attractiveness towards Bitcoin. The findings summarized in Table 5 do not change substantially. We always show that the rising anxiety over coronavirus positively affect the Bitcoin prices. Worries about the rapid spread of the coronavirus is one of the potential factors rising recently the bitcoin, an asset that often has gone up when investors are nervous.

Table 5. The impact of coronavirus on Bitcoin cumulative abnormal volatility: Wikipedia as measure of the attention to Bitcoin

	CAR(0)	CAR(5)	CAR(10)	CAR(20)
Constant	5.1378**	7.1145***	6.1345***	6.1456***
	(0.0019)	(0.00000)	(0.0006)	(0.0004)
Coronavirus	**-0.1345**	**0.1026**	**0.0003***	**0.0924*** **
	(0.6148)	**(0.4317)**	**(0.0491)**	**(0.0000)**
VC	-0.1241*	-0.1093*	-0.1129***	-0.1025*
	(0.0309)	(0.0411)	(0.0006)	(0.0153)
ETR	0.1427***	0.1158**	0.1248**	0.1619**
	(0.0003)	(0.0014)	(0.0157)	(0.0032)
GP	-0.0013	-0.0009***	-0.0006***	-0.0012**
	(0.1624)	(0.0000)	(0.0002)	(0.0031)
Wikipedia	0.0449***	0.1279**	0.0652*	0.0751*
	(0.0001)	(0.0025)	(0.0411)	(0.0310)
HR	-0.0014***	-0.0011**	-0.0023**	-0.0042**
	(0.0007)	(0.0062)	(0.0098)	(0.0081)
Adjusted R^2	0.86	0.79	0.77	0.90
F-value	5.0932	4.9723	3.8914	4.3855

Notes: All regressions are controlled for heteroskedasticity, and the p-values are given in parentheses. $*$, $**$, $***$
denote statistical significance at the 10%, 5% and 1% levels, respectively.

Cumulative abnormal volatility

a) Different event window

We reconduct the event study methodology while considering the Bitcoin conditional variance but for a different window (120 days). We usually show that the Bitcoin volatility does not react immediately to the virus shock (see Table 6). The prices take some days to significantly respond to the coronavirus. After twenty days, we can see more clearly the effect of coronavirus on the price of Bitcoin. This means that the coronavirus leads to high-frequency price changes of Bitcoin rather than consolidates its position as a safe haven asset. We also confirm that the three Bitcoin features (i.e., safe haven, volatile and inefficient) are significantly related. Specifically, the Bitcoin price responds positively to coronavirus, which means that it acts as a "safe haven". But Bitcoin does not share the characteristics of traditional safe haven assets (in particular, gold) as we note a rising volatility with the coronavirus spreads. Add to this that the Bitcoin's reaction is not immediate, spotlighting its inefficiency. The latter is itself linked to the speculative and volatile behavior of Bitcoin.

The impacts of the explanatory variables on the Bitcoin price are still also fairly robust. The same exercise has been conducted for the simple market model and we globally find consistent results. To keep our presentation simple, the results will be available for interested readers upon request.

Table 6. The impact of coronavirus on Bitcoin cumulative abnormal volatility: Different window (120 days)

	CAV(0)	CAV(5)	CAV(10)	CAV(20)
Constant	4.2567***	5.1023***	6.0923***	4.7234***
	(0.0000)	(0.0008)	(0.0000)	(0.0321)
Coronavirus	**0.1651**	**0.0013****	**0.1382*****	**0.1894****
	(0.4420)	**(0.0048)**	**(0.0009)**	**(0.0014)**
VC	-1578**	-0.1716**	-0.1208**	-0.110134
	(0.0018)	(0.0052)	(0.0066)	(0.4652)
ETR	0.1358**	0.1378***	0.13024*	0.15121*
	(0.0017)	(0.0009)	(0.281)	(0.0169)
GP	-0.0052	-0.0036*	-0.0059***	-0.00491***
	(0.1258)	(0.0513)	(0.0000)	(0.0004)
GTR	0.0872***	0.1045**	0.1061*	0.1028*
	(0.0003)	(0.0021)	(0.0254)	(0.0143)
HR	-0.0014**	-0.0046***	0.0442	-0.0097*
	(0.0010)	(0.0007)	(0.3492)	(0.0642)
Adjusted R^2	0.80	0.79	0.84	0.81
F-value	3.9124	3.5692	5.1238	3.9244

Notes: All regressions are controlled for heteroskedasticity, and the p-values are given in parentheses. ∗, ∗∗, ∗∗∗
denote statistical significance at the 10%, 5% and 1% levels, respectively.

b) Further control variables

We re-assess the response of Bitcoin conditional variance to coronavirus event while replacing the attention to Bitcoin indicator (Google Trends) by another proxy. Specifically, we include the attractiveness towards Bitcoin measured via Wikipedia in the list of regressors to check for the robustness of the independent variables' coefficients. The results reported in Table 7 do not appear sensitive to the incorporation of Wikipedia as investors attractiveness proxy. We often find that the uncertainty surrounding the emergence of coronavirus has exacerbated its volatility, a characteristic that may be taken against Bitcoin, and against functioning as a store of value and thereafter as a safe haven investment.

Table 7. The impact of coronavirus on Bitcoin cumulative abnormal volatility: Wikipedia as measure of the attention to Bitcoin

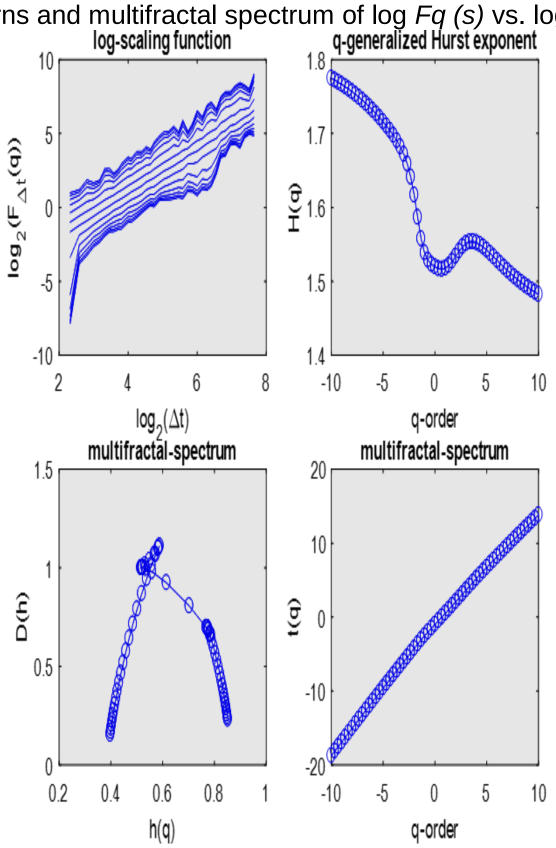
	CAV(0)	CAV(5)	CAV(10)	CAV(20)
Constant	2.9872***	4.0923**	4.1346**	4.2568**
	(0.0004)	(0.0052)	(0.0012)	(0.0031)
Coronavirus	**0.0594**	**0.0017****	**0.1123*****	**0.1362*****
	(0.2248)	**(0.0062)**	**(0.0007)**	**(0.0000)**
VC	-0.1621***	-0.1592**	-0.14438**	-0.141092**
	(0.0003)	(0.0081)	(0.0011)	(0.0012)
ETR	0.1278**	0.1083***	0.14618*	0.13678*
	(0.0016)	(0.0001)	(0.0214)	(0.0196)
GP	-0.0007***	-0.0012***	-0.00432**	-0.004235
	(0.0000)	(0.0003)	(0.0044)	(0.1052)
Wikipedia	0.1181***	0.1462***	0.092810*	0.111235*
	(0.0007)	(0.0004)	(0.0613)	(0.0595)
HR	-0.0003**	-0.0010**	-0.00415*	-0.00167*
	(0.0012)	(0.0043)	(0.0288)	(0.0194)
Adjusted R^2	0.91	0.88	0.84	0.90
F-value	6.2349	5.1387	4.2209	4.3855

Notes: All regressions are controlled for heteroskedasticity, and the p-values are given in parentheses. ∗, ∗∗, ∗∗∗
denote statistical significance at the 10%, 5% and 1% levels, respectively.

Alternative technique for inefficiency hypothesis

The efficient market hypothesis (EMH) has been investigated in the literature for many traditional financial assets by conducting the event study methodology. To confirm the inefficiency of Bitcoin market, we use a newly technique namely the Multifractal Detrended Fluctuation Analysis[8] to test whether the efficiency of Bitcoin changes over time. Figure 1 depicts the multiscaling behavior of the fluctuations *Fq (s)* versus the time scales *s*. One crossover point can be seen which is due to a change in the properties of the Bitcoin returns at dissimilar scales of time. We also observe that the function *h(q)* presents a nonlinear decreasing form for increasing values of *q* which highlights the multifractal and complex nature of Bitcoin.

Figure 1. Dynamic returns and multifractal spectrum of log *Fq (s)* vs. logs of the Bitcoin returns



The generalized Hurst exponents for different small- and large-time scales can reflect the autocorrelated behavior of the Bitcoin market in the short- and long-term horizons. For our case, we investigate the behaviors for the scales of both less than and more than 20 days. Table 6 summarizes the generalized Hurst exponents for s < 20 and s > 20 with q varying from
−5 to 5. We note that all of the generalized Hurst exponents are larger than 0.5 for s < 20, implying that all kinds of the Bitcoin variations are persistent in the short-term.

Table 6. The generalized Hurst exponents of Bitcoin returns with *q* varying from -5 to 5

Original series: Bitcoin returns		
q	*s<20*	*s>20*
-5	0.5983	0.6018
-4	0.6823	0.6178
-3	0.5789	0.5578
-2	0.5582	0.5781
-1	0.5124	0.5210
0	0.4983	0.5134
1	0.5378	0.3891
2	0.5892	0.4235
3	0.5980	0.3379
4	0.6134	0.3154
5	0.6342	0.3962

Table 7 provides the mean values of *IDM* in Equation (6) during periods of upward and downward linear trends of the Bitcoin prices for the two window lengths under study (120 and 260 days). To test the significance of the difference of *IDM*, we utilize the following equation:

$IDM_i = \alpha + \beta * D_i + \varepsilon_i$ (6)

Where IDM_i describes the value of *IDM* defined in Equation (6) for the Bitcoin return series in the i^{th} rolling window. D_i is a binary variable where D_i equals 1 if the Bitcoin price in the i^{th} time window shows an upward trend, and D_i equals 0 otherwise. Finally, ε_i is the stochastic noise.

The results are reported in Table 7. For different window lengths, we note that the *IDM* mean value during the upward period is weaker than during the downward period. Thus, the Bitcoin market seems more efficient over downward periods. So, we add to our assessment that the market efficiency changes over time. A tactical approach should be conducted since holding a position towards Bitcoin over short-term horizons or during upward periods may lead to investment losses.

Table 7. *IDM* mean values during downward and upward periods

Window lengths	Downward trends	Upward trends	t-statistics
120	0.7134	0.4418	-6.3452***
260	0.5926	0.3627	-8.0964***

Note: ∗∗∗ denotes statistical significance at the 1% level.

IV. Discussion of results and conclusions

When the severe acute respiratory syndrome (SARS) virus hit the Chinese economy in 2003, everyone was at the start very pessimistic about the possible harmful SARS economic consequences. But as soon as the epidemic was contained, the economic growth rebounded markedly, and rose by 10% in the same year. China is unlikely to be that lucky this time mainly owing to unfavorable domestic and external economic conditions (i.e., the continued China's economic slowdown, China-U.S. trade war). So, with the new deadly coronavirus still on the rampage, the Chinese authorities must prepare for the worst. This situation seems very problematic in a country that has the second largest economy in the world. This implies that the coronavirus would have detrimental effect on the global trade and in turn the global economy.[9] But *what does this have to do with Bitcoin?*

The present article has three main objectives. First, we test whether Bitcoin serves as a safe haven investment amid uncertainty surrounding the emergence of coronavirus. Second, we test whether this deadly virus exacerbates the volatility of Bitcoin. Third, we assess if Bitcoin follows the efficient market hypothesis. When considering the abnormal stock returns, we find that the start of coronavirus reinforces the position of Bitcoin as an attractive safe haven asset. But by accounting for the abnormal volatility, it is shown that the virus intensifies the volatility of Bitcoin, suggesting therefore that despite its great volatility Bitcoin is still keeping its position as a safe haven. We also confirm the inefficiency of the Bitcoin market as the response takes times to be reflected in the prices and as time passes, the reaction is not contained. These different elements are likely to be highly linked. It is shown that the response to the coronavirus event is not immediate, which is due to its inefficiency. The latter is ultimately due to the very speculative nature of this asset confirmed by its persistent volatility. This suggests that investment in Bitcoin entails an accurate understanding of the associated risks but also confirms the role of Bitcoin as a safe haven in periods of turmoil.

It seems interesting to note that while investors and traders generally tend to consider gold and other precious metals as safe havens because of their stability, the Bitcoin is chosen as a safe haven despite its inefficiency and its high volatility. This brings us to take a new look at the concept of safe haven. Cryptocurrencies (and in particular, Bitcoin) tend to overturn this concept. We can speak here of a safe haven specific to cryptocurrencies which is different from that usually used for conventional assets such as gold, the dollar... It is called "crypto safe haven". We'll specify this notion by answering the following question: *Why should we consider Bitcoin as a safe haven asset amid uncertainty over coronavirus spreads?*

Despite its multiple drawbacks, Bitcoin can be considered a safe haven asset. Indeed, one of the characteristics of Bitcoin is its relative simplicity in terms of monetary mechanism and policies. It is an asset that can be traded easily, without any party having more information than the other. On several occasions, Bitcoin has played its role as a safe haven: the Greek crisis, the Cypriot crisis, Brexit, China's deepening slowdown, India's demonetization, Venezuela's crisis, among others. For all these cases, people want to park their black money (in old currency notes) in Bitcoins with hopes to obtain an alternative currency, driving up the Bitcoin price. In fact, the loss of faith in the stability of banking system and the future economic security worsened, and market uncertainty heightened across the globe. Bitcoin which lives outside the confines of a single country's politics has profited from the ongoing volatility. However, Bitcoin does not appear to share the characteristics of traditional safe-haven investments such as gold. Even though Bitcoin is a liquid asset even in times of market turmoil, it is a high-risk, volatile and speculative investment. Another drawback is linked to the fact that Bitcoin is exposed to some deep flaws. For instance the sudden death of the owner of Canada's biggest cryptocurrency exchange lefting around £145 million of cryptocurrency locked in a digital wallet to which he reportedly had the only password. The Vancouver-based exchange indicated in a blog post that his death implies they will be unable to pay customers around £41 million in bitcoin and other cryptocurrencies that they're owed, leading to huge conspiracy theories over the whereabouts of the funds.[10]

Despite all of the above, it's not easier to affirm that the marked reaction in the Bitcoin price (i.e., abnormal return and volatility) is dominantly due to Coronavirus. To have a clearer idea about the recent Bitcoin's evolution, we shouldn't neglect the fact that the Bitcoin halving, which will cut the mining reward of Bitcoin in half in May of 2020[11]. Bitcoin price predictions have long pointed at the event as a catalyst for greater prices, and it's logical to assume that at least some of the steady increase is due to this event. Whatever the reason, two things seem certain: (i) despite its volatility and inefficiency, Bitcoin keeps its safe haven feature, and

(ii) the coronavirus outbreak has the potential to prompt severe economic and market dislocation. But the intensity of the effect will ultimately be measured by how and to what extent the virus spreads and evolves, which is impossible to properly predict, as well as how

governments will react. Recently and as the Chinese government continues its drastic efforts to halt the coronavirus spreads, the China's central bank makes known it plans to sanitize the banknotes from high-risk areas. Once again, the control of money by the government has been proof of why the world requires cryptocurrency (in particular, Bitcoin). Its decentralization implies that the government cannot control its distribution or allocations as it is done currently. Moreover, with the continued rise of digital paying platforms and tools, the use of cash has steadily collapsed.

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Appendix A

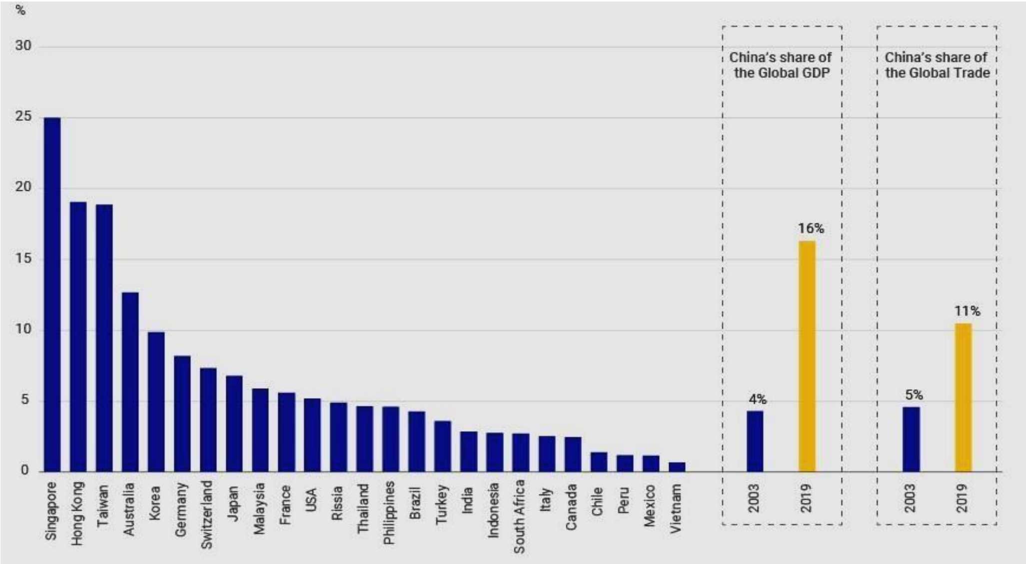

Figure A1. The financial costs of coronavirus: A comparison with the 2003 SARS
Source: MSCI Economics Exposure Database, IMF World Economic Outlook, World Bank.

Figure A2. The evolution of Bitcoin price and its response to coronavirus
Source: CoinDesk (www.coindesk.com/price).

Table A1. Data sources

Variables	Definition	Sources
BPI	The Bitcoin price index	CoinDesk (www.coindesk.com/price)
VC	The velocity of Bitcoin	Blockchain (http://www.blockchain.info)
ETR	The exchange trade ratio	Blockchain(http://www.blockchain.info)
GP	The gold price	DataStream of Thomson Reuters
GTR	The attention towards Bitcoin	Google Trends (http://trends.google.com)
HR	The hash rate	Blockchain (http://www.blockchain.info)

Appendix B.
An overview about the MF-DFA

The MF-DFA method is a generalization of the Detrended Fluctuation Analysis, which consists of five s teps. Let assume that $\{x_t, t = 1, \dots, N\}$be a time series of length N.
Step 1: we determinethe "profile" y_k of the time series *x(k)* for *k = 1,… , N*, as:

$y_k = \sum_{t=1}^{k} [x_i - \bar{x}]$, $k = 1, \dots, N$ (a.1)

where $\bar{x}$ denotes the average over the whole time series.

Step 2: we divide the "profile" y_k into $N_S \equiv {}^N/_S$non-overlapping segments of equal lengths where *s* is t he scale.

Step 3: we estimate a local trend by fitting a polynomial to the data. Thereafter, we calculate the varian ces by the two following formulas, depending on the segment *v*:

$F^2(s, v) = \frac{1}{s} \sum_{i=1}^{s} \{Y[(v-1)s + i] - y_v(i)\}^2$(a.2)

for$v = 1,2, \cdots, N_S$, and

$F^2(s, v) = \frac{1}{s} \sum_{i=1}^{s} \{Y[N - (v - N_S)s + i] - y_v(i)\}^2$ (a.3)

for$v = N_S + 1, \cdots, 2N_S$.
Step 4: By averaging the variances over all segments, we obtain the q^{th} order fluctuation function:

$F_q(s) = \{\frac{1}{2N_S} \sum_{v=1}^{2N_S} [F^2(s, v)]^{q/2}\}^{1/q}$ (a.4)

where the index variable *q* can take any real values except zero. For *q = 2*, the standard DFA procedur e is retrieved.

Step 5: we investigate the multiscaling behavior of the fluctuation functions *Fq (s)* by determining the sl ope of log-log plots of *Fq (s)* vs. *s* for various values of *q*.

$F_q(s) \sim s^{h(q)}$ (a.5)
The time series is multifractal if$h(q)$depends on *q*.

It is well documented that the generalized Hurst exponent *h(q)* defined by the MF-DFA is linked to the multifractal scaling exponent *τ(q)* known as the Rényi exponent:

τ(q) = qh(q) – 1 (a.6)

Ultimately, we test the efficiency of the Bitcoin market by using the inefficiency index based on the multifractal dimension (*IDM*), given by:

$$ID = \frac{1}{2}\left(|h(-5) - 0.5| + |h(5) - 0.5|\right) = \frac{1}{2}\Delta h \qquad \text{(a.7)}$$

The Bitcoin market is efficient if the value of *IDM* is close to zero, while strong *IDM* values indicate a less efficient market.

Praveena L. "Coronavirus Spreads and Bitcoin's 2020 Rally: Is There a Link?." *IOSR Journal of Business and Management (IOSR-JBM)*, 22(4), 2020, pp. 34-49.