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An event study analysis of Bitcoin and Altcoins under COVID-19

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Abstract

Operating through blockchain, cryptocurrencies eliminate intermediaries and encourage transparency between parties. Although Bitcoin continues to be the most widely used cryptocurrency, its increased attractiveness to investors has led to the emergence of Altcoins (alternative cryptocurrencies other than Bitcoin). Employing an event study approach using the daily price series for the sample period from 1 January 2018 to 17 July 2020, the study aims to determine the impact of Covid-19 on the value of both Bitcoin and Altcoins. The evidence shows that the abnormal returns of Bitcoin and Altcoins around Covid-19 dates are negative and Altcoins are more adversely affected by the pandemic than Bitcoin. The study also documents that most altcoins rely on the same block chain technology aiming to complement or improve certain Bitcoin characteristics, and the high correlation between Bitcoin and Altcoins are likely to fail cross-currency hedging strategies during the pandemic crisis.

Keywords: Cryptocurrency: Blockchain, Bitcoin, Altcoins; Event Study.

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1. Introduction

Operating through blockchain cryptocurrencies eliminate intermediaries and encourage transparency between parties. Cryptocurrencies provide investment opportunities with 'safe heaven' properties and they can serve as a hedge against Covid-19.[1] Bitcoin continues to be the most widely used cryptocurrency and is the largest in terms of the total cryptocurrency market capitalization, and the number of daily transactions. However, the rise of Bitcoin and its increased attractiveness to investors have led to the emergence of Altcoins (alternative cryptocurrencies other than Bitcoin) most of which rely on the same block chain technology aiming to complement or improve certain Bitcoin characteristics. The total supply of cryptocurrency is predetermined, and the supply shown on the e-market is only the amount of cryptocurrency market players are selling at that moment at the given prices. Although the main sources of cryptocurrency remain mining and trading on electronic markets, legislation changes in countries affect the value of cryptocurrencies. Awareness affects the exchange rate, and high awareness has made Bitcoin the market leader.

With the purpose of conducting a detailed investigation, the present study aims to reveal important information about how Bitcoin and Altcoins are likely to react to Covid-19 and predict the impact of the pandemic using a set of covariates which determine the prices of Bitcoin and Altcoins. Employing an event study approach using the daily price series for the sample period from 1 January 2018 to 17 July 2020, the study aims to determine the impact of Covid-19 on the value of both Bitcoin and Altcoins.

Analysing the daily prices of Bitcoin and 14 Altcoins, the study tests two hypotheses related to abnormal returns around the Covid-19 event dates. Hypotheses 1 and 2 state that the abnormal returns of Bitcoin and Altcoins around Covid-19 dates are negative and hypothesis 3 postulates that Altcoins are more adversely affected by the pandemic than Bitcoin. Following the previous literature on the impact of Covid-19 on cryptocurrencies, the study also controls for supply and demand drivers (trading volume and circulating supply) in determining the prices of Bitcoin and Altcoins in the multivariate approach. The study employed the propensity score matching (PSM) method to estimate the Average Treatment Effect (ATE) of Covid-19.

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[1] The notion of an investment 'safe heaven' refers to investors seeking out assets that are uncorrelated or negatively correlated during periods of market crisis.

Documenting the cryptocurrency markets' reaction to the Covid-19 induced crisis, the contribution of the research is three-fold. First, the study fills in the existing gap related to the lack of academic research on the impact of Covid-19 on the value of crypto assets. Second, as the sample period covers the most recent market crisis caused by the pandemic, the findings can provide useful insights for investors, traders, and risk managers in cryptocurrency markets. Third, the study documents a high level of coherence between the panic level and the dynamics of leading cryptocurrencies, thus evidencing that the high correlation between Bitcoin and Altcoins are likely to fail cross-currency hedging strategies during the pandemic crisis. The research findings are important for the cryptocurrency market players in their attempts to comprehend and forecast the behaviour of crypto assets during the Covid-19 crisis.

The escalation of Covid-19 to a global pandemic and its impact beyond mortality and morbidity have created serious risk among network participants and potential investors.[2] Prior studies, although limited, provide conflicting conclusions regarding the impact of Covid-19 on the value of cryptocurrencies. Some studies have recommended cryptocurrencies as a good investment option during the pandemic due to their wide acceptance and lack of regulation, however, others have identified a downward movement of cryptocurrency returns. The motivation for the study is incentivized by these research inconsistencies on the impact of Covid-19 on the crypto market.

Building up on the recent research efforts which include Demir *et al.*, (2020), Conlon and McGee (2020), Corbet *et al.* (2020), Conlon *et al*. (2020), Kristoufek (2020), Lahmiri and Bekiros (2020), Grobys and Sapkota (2020) and Goodell and Goutte (2020), the study examines the impact of Covid-19 on cryptocurrencies. The study differs from prior studies in several ways. First, the present study employs an event study method using daily prices of Bitcoin and a select sample of Altcoins based on market capitalization to assess the extent to which investors earn excess cryptocurrency returns from Covid-19 event. Second, the sample period used for the study is between 1 January 2018 and July 17, 2020 which includes the Incubation (Thursday, 2 January 2020 to Friday, 17 January 2020), Outbreak (Monday, 20 January 2020 to Friday 21 February 2020) and Fever (Monday 24 February 2020 to 6 March 2020) periods of the pandemic. Third,

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[2.] Mortality refers to those who die, and morbidity denotes those who are incapacitated or caring for the incapacitated and unable to work for a period.

the study employed both univariate and multivariate analysis using linear and logistic regressions with a Covid-Dummy variable to predict the effect of the pandemic on cryptocurrency values using a set of covariates such as trading volume, circulating supply and market capitalization. Furthermore, the study used the technique of propensity score matching (PSM) to estimate the average casual effects of Covid-19 using the scaler variable, propensity score.

The evidence from the study provides mixed results. Although both the event study and multivariate analysis show a trend of declining cryptocurrency values, only the logistic regression estimates provide strong evidence of a negative impact of Covid-19. The event study and both the univariate and multivariate analysis demonstrate that Altcoins are more adversely affected than Bitcoin. The propensity score matching employed for removing selection bias too shows mixed results. The model with an inclusion of abnormal returns in covariates shows a strong negative effect of the pandemic.[3] The empirical findings for hypotheses 1 and 2 suggest that Bitcoin and Altcoin prices are indeed interdependent and the abnormal returns around Covid -19 dates are negative. However, given that Bitcoin consistently impacts all Altcoins, the results suggest that Hypothesis 1 tends to dominate over Hypothesis 2. The event study and both the univariate and multivariate analysis demonstrate that Altcoins are more adversely affected than Bitcoin, supporting Hypothesis 3.

The rest of the paper is organized as follows. Section 2 briefly describes the main innovations in crypto markets. Section 3 reviews previous studies examining the impact of COVID-19 on the cryptocurrency market. Section 4 explains the data and methodology. Section 5 discusses the results, and finally, Section 6 concludes the paper.

2. Innovations in crypto markets

Bitcoin and Altcoins are a chain of digital signatures stored in a personal or online 'wallet' and the ownership transfers are executed through a hash function using the public keys of owners.[4] The double-spending (digital copying)

[3.] Two models were estimated with the former excluding abnormal returns in covariates and the latter making an inclusion of abnormal return. The results of the second model show a strong negative effect of Covid-19 on cryptocurrencies.

[4.] A wallet is a software programme that stores Bitcoin and Altcoins, and the owner has a private key (secret number) corresponding to the address of the wallet. Transfer of ownership of cryptocurrencies is done through the public keys of owners. A hash function is an algorithm used to record new transactions into the block chain through the mining process.

problem is solved through the consensus mechanism (Proof of Work (PoW) and Proof of Stake (PoS)) using a peer-to-peer transaction system.[5] Most Altcoins improve certain Bitcoin features like reducing computing power for mining (Litecoin), enhancing security (Peer Coin), accelerating transactions (Dash), and introducing smart contracts (Bitshares and Ethereum).

The 'Proof of Work' consensus mechanism appears to provide a more robust block chain than the 'Proof of Stake' mechanism. However, crypto networks providing more staking rewards are now attracting more users. The staking networks (Cosmos, Decred, Synthetix, Waves) enable cryptocurrency holders to lock up their PoS coins in staking wallets. However, staking not only dilutes everyone's holdings through an increase in the circulating supply but also may increase the risk of loss when measured in Bitcoin.

The high price volatility of Bitcoin and Altcoins has prompted the introduction of cryptocurrency derivatives recently. Without having to buy, the cryptocurrency investors may lock in the prices of Bitcoin and Altcoins to hedge against the losses from adverse price movements. The introduction of Decentralized Finance (DeFi) on the Ethereum platform and an increase in open interest in the ether (ETH) futures and options markets have increased the interest of investors in the crypto market. The development of exchange traded funds in Bitcoin (VanEcK) and the launching of Bitcoin futures in 2017 by the Chicago Mercantile Exchange (CME) have raised the credibility of cryptocurrencies.

Tokenization is the latest innovation in the crypto market, and employing Ethereum's smart contracts, companies now issue tokens (Initial Coin Offerings) using the decentralized applications (Dapps). A coin (e.g. Bitcoin, Ether, and Ripple) transfers value and incentivizes the network participants to use the block chain, whereas tokens provide capital to companies. Companies issue tokens to gain stakeholders in the product ecosystem and the purchasers gain product value, not necessarily cash value. Stakeholders who are already part of the product ecosystem are the primary buyers in a token sale. The speculators buy tokens with the expectation that the token value will rise. Equity token

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[5] PoW and PoS are requirements for transactions to take place on a block chain. Under the Bitcoin protocol, each computer participant (node) uses the SHA-256 hashing function to solve a computation puzzle. Once the node finds the solution, a new block is added in the block chain and broadcasted to all nodes. The node that solves the puzzle (now the miner) is rewarded with a fee and a newly minted Bitcoin. However, under PoS, the miner must own some coins to verify a transaction on the block chain and receive the reward (new coins or transaction fees).

offerings (ETO), a hybrid of initial public offerings (IPO), initial coin offerings (ICO) and venture capital investing, provide equity-like rights for the investors.

3. Literature review and hypothesis development

3.1. Prior studies

Conlon and McGee (2020) showed that the inclusion of Bitcoin in the S&P 500 portfolio increased the downside risk creating doubt about Bitcoin's ability to provide a safe hedge against the pandemic. Corbet *et al.* (2020) documented significant correlations between Bitcoin and Chinese equity returns during Covid-19. Corbet, Larkin and Lucey (2020) observed that Bitcoin and Ethereum are not a safe hedge during the pandemic. However, Tether has been found to be a good hedge. Studying the correlation between Bitcoin and S&P500, Kristoufek (2020) found gold served as a better hedge than Bitcoin during Covid-19. Similar conclusions have been drawn by Lahmiri and Bekiros (2020) and Grobys and Sapkota (2020). However, Goodell and Goutte (2020) argued that Covid-19 has triggered a price rise in Bitcoin. Examining the herding behaviour in the crypto market, Yarovaya *et al.* (2020) observed no such behaviour in investors.

There is evidence to suggest that Bitcoin and Altcoin prices are correlated, and this has been confirmed by Gandal and Halaburda (2016) and Osterrieder *et al*. (2017). However, these studies had small samples and did not consider the external drivers in the determination of their prices. The prices of Ethereum, LiteCoin, Dash, DogeCoin, Monero, NameCoin and Counter Party would show a stronger correlation with Bitcoin price than the prices of other Altcoins since all are based on PoW. Given that other Altcoins have mostly adopted PoS, they would show a weaker relationship with the Bitcoin price. For Altcoins based on the PoS, the relationship with the Bitcoin price would be smaller and weaker compared to Altcoins based on PoW. This could suggest that the Covid-19 shock to Bitcoin price may impact the values of Altcoins with PoW more adversely than Altcoins with PoS.

Prior studies, thus, provide conflicting conclusions about the impact of Covid-19 on the value of cryptocurrencies. There are studies that have recommended cryptocurrencies as a good hedge against the pandemic, however, there is also evidence in prior studies to show a downward trend in cryptocurrency returns during the pandemic. These research inconsistencies highlight gaps in terms of the impact of Covid-19 on cryptocurrency values and the co-movement of cryptocurrency returns with equity returns which require further investigation.

3.2. Testable hypotheses

Bitcoin price is highly volatile reaching a high of US$20,000 in November 2017. The price declined later with the Bitcoin price falling below US$4000 in 2018. However, these numbers become insignificant compared to the price changes that other Altcoins have, especially after their initial launch. It is possible that the market wide shock of Covid-19 might have induced a strong contagion effect triggering the prices of Bitcoin and Altcoins to move in the same direction. This could have caused a decreased relative valuation changes in Bitcoin and Altcoins during the pandemic. Covid-19 is, thus, likely to generate negative abnormal returns both for Bitcoin and Altcoins due to the contagion effect. The first and second hypotheses in alternative form are specified as:

H1: The abnormal returns of Bitcoin around the event (Covid-19) dates are negative.

H2: The abnormal returns of Altcoins around the event (Covid-19) dates are negative.

Altcoins with a PoS are likely to show stronger negative abnormal returns than Altcoins with a PoW. This is possible because Altcoins with a PoW are mostly convertible into Bitcoin whereas Altcoins with a PoS do not have this facility. However, both the types of Altcoins are generally affected by the volatility of Bitcoin as they are either directly or indirectly pegged to the value of Bitcoin. This is because Bitcoin is the market leader, widely used and accepted in transactions. Thus, the third hypothesis stated in alternative form takes the following specification:

H3: Altcoins are more adversely affected by Covid-19 than Bitcoin.

4. Data and methodology

The trading data on cryptocurrency were extracted from Coin Market Cap for the sample period between 1 January 2018, and July 17, 2020. Besides the daily price in US dollars, market capitalization, circulating supply and trading volume were also included in the cryptocurrency dataset. The Crescent Crypto Market Index (CCMIX) extracted from Crescent Crypto.Com was taken as it includes approximately 90% of the investable cryptocurrencies. The other sources of data include Bitcoincharts, Quandl, Messari, Coinpaprika, Blockmodo, Coinratecap, Coingecko, CoinDesk.com, Coincodex and Yahoo Finance.

The study employed an event study method to examine the impact of Covid-19 on cryptocurrencies (Masulis, 1980).[6] The date on which Covid-19 was declared as a global pandemic by the World Health Organization (WHO) (11 March 2020) was taken as the event date (t = 0). The 11 days enclosing Covid-19 (i.e., t = -5…., 0…., +5) were labelled as the event window. The days prior to Covid-19 period (i.e., -250…-10) were labelled as the estimation period. The abnormal returns (AR) for the event window were computed using the log returns of the sampled cryptocurrencies (14) and the crypto index (CCMIX). The study also examined the average abnormal and average cumulative abnormal returns using an event window of 21 days around Covid-19 (t = -10……, 0….. +10).

The expected returns for the window period (ER) were calculated using the observations of the estimation period by employing both the mean adjusted returns and the single factor market model. Under the mean adjusted returns,

$$\text{Abnormal Return}_{j,t} = (\text{Observed Return}_{j,t} - \text{Expected Return}_{j}) \quad (1)$$

Where Abnormal Return,j,t is the abnormal return of the cryptocurrency j in time period t, Observed Retrun,j,t is the observed return of the cryptocurrency j in time period t, and Expected Return,j is the expected or average return of the cryptocurrency j over a given sample period. The choice of the constant mean model is justified by the observation of Brown and Warner (1985) that the constant mean model often gives results like those of the complicated models.[7]

The market model relates the return of any given cryptocurrency to the return of the market portfolio. For any cryptocurrency i we have

$$\text{Cryptocurrency Return}_{i,t} = \alpha_i + \beta_i \text{ Market Return}_t + \varepsilon_{it} \quad (2)$$

Where, Cryptocurrency $\text{Return}_{i,t}$ and Market Return_t are the period-t returns on cryptocurrency i and the market portfolio, respectively, and εit is the disturbance term. α_i and β_i are the parameters of the market model. The rationale of using the market model is to increase the ability to detect event effects which is achieved by reducing the variance of the abnormal returns.

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[6] Although Covid-19 is still active, the sample period of the study includes the three important milestones in the initial outbreak of Covid-19 namely Incubation (Thursday, 2 January 2020 to Friday, 17 January), Outbreak (Monday, 20 January to Friday 21 February) and Fever (Monday 24 February to 6 March).

[7] Brown and Warner (1985) argued that the variance of abnormal returns is not reduced much by choosing a more complicated model.

The Abnormal Returns (AR) were computed by deducting the Actual Returns (AR) from the Expected Returns (ER). The Cumulative Abnormal Returns (CAR) for the event window was estimated by adding the daily AR for the entire event window. The student t– test is computed to assess the statistically significant difference in the mean returns before and after Covid-19.

The study employed both univariate and multivariate analysis and the multivariate analysis included the estimations of linear and logistic regressions. The estimated abnormal returns from the event study method (single factor market model) was regressed against a set of covariates. In the logistic regression estimation, Bitcoin (BTC)-Altcoins (ATC) Dummy was used as a dependent variable to ascertain the differential impact of Covid-19 on Bitcoin and Altcoins. The linear and logistic models are specified in equations (3) and (4).

$$\text{Abnormal Returns}_i = \beta 0 + \beta 1 \text{ Covid-Dummy} + \beta 2 \text{ Circulating Supply}_i + \beta 3 \text{ Volume}_i + \beta 4 \text{ Market Capitalization}_i + \varepsilon_i \quad (3)$$

Where, the coefficients given by β0, β1, β2, β3 and β4 are all unknown parameters and ε_i is an error term. The Covid-Dummy variable takes a value of 1 for observations post the declaration of Covid-19 as a global pandemic by the WHO (11 March 2020) and 0 otherwise. Volume is an important metric showing the coin's direction and movement. Volume is the amount of the coin that has been traded on the exchange in the last 24 hours. The circulating supply variable denotes the number of coins that are active on the crypto market and available at that moment. The circulating supply metric is used in the calculation of market capitalization (Coin's Price * Circulating Supply).

$$\text{BTC-ATC Dummy} = \beta 0 + \beta 1 \text{ Covid-Dummy} + \beta 2 \text{ Circulating Supply}_i + \beta 3 \text{ Volume}_i + \beta 4 \text{ Market Capitalizaation}_i + \varepsilon_i \quad (4)$$

Where the BTC-ATC Dummy variable takes a value of 1 for Bitcoin observations and 0 for Altcoin observations. The meaning of the other variables is the same as in Equation (3).

As a robustness test, the study employed the technique of propensity score matching (PSM) to estimate the effect of Covid-19 by accounting for the covariates that predict the effect of the pandemic.[8] Using the PSM, the study aims to estimate the average casual effects of Covid-19 using the scaler variable, propensity score. Applying the logistic treatment model, the PSM estimates

[8] Propensity score is defined as the conditional probability of the exposure given the observed covariates.

the ATE (Average Treatment Effect) by finding matches for both the Covid-19 affected (treated subjects) and non-Covid-19 affected observations (control subjects). The estimation of ATE involves the selection of an appropriate model (logistic model), matching across individual observations in the treated (Post-Covid-19 observations) and non-treated (Pre-Covid-19 observations) groups based on propensity scores, and stratification (creating strata in the treated and non-treated groups). Finally, the ATE is computed as the weighted average of the differences of means of the strata.

5. Discussion of results

5.1. Event study results (univariate analysis)

Table 1 displays the summary statistics of Cumulative Abnormal Returns (CAR) and Cumulative Average Abnormal Returns (CAAR) of Bitcoin and Altcoins both under the constant mean and the single factor market models. In the 5-day event window period, Bitcoin (BTC) shows positive mean and median CAR (0.3649, 0.5039) with a standard deviation of 0.2436. However, when BTC is added to Altcoins, the mean and median figures of CAAR display negative values (-0.5242, -0.5677) with a standard deviation of 0.6030. A possible reason for this could be the nullification of the positive market value of BTC by the sharp decline in the values of Altcoins. This is evident when BTC is excluded in the CAAR calculation and the Altcoin CAAR shows negative mean and median values (-0.5926,-0.6418).

If the event window is extended to a 10-day period, BTC still exhibits positive values for mean and median CAR (0.2468, 0.3619), whereas the CAARs of BTC plus Altcoins and Altcoins alone show declining tendencies (see Panel B of Table 1). Examining the single factor market model, all the three groups show negative mean and median CAARs (see Panels C and D of Table 1). For the 5-day event window the BTC mean and median CAR (-0.0906, -0.0903) decline is less than the BTC plus Altcoin values (-0.1390,-0.1503). However, Altcoins show sharp decline with a mean and median CAAR of -0.1428 and -0.1542, respectively. The situation is similar in the 10-day event window period as well (see Panel D of Table 1).

Table 1: Summary Statistics

Panel A: Five- Day Event Window (Constant Mean Model)					
	Mean	Median	SD	Min	Max
BTC CAR	0.3649	0.5039	0.2436	0.0236	0.6205
BTC+Altcoin CAAR	-0.5242	-0.5677	0.6030	-0.6392	-0.6776
Altcoin CAAR	-0.5926	-0.6418	0.6817	-0.7227	-0.7662
Panel B:Ten- Day Event Window (Constant Mean Model)					
	Mean	Median	SD	Min	Max
BTC CAR	0.2468	0.3619	0.2444	-0.0619	0.5586
BTC+Altcoin CAAR	-0.0186	-0.0197	0.0207	-0.0219	-0.0232
Altcoin CAAR	-0.2990	-0.3167	0.3340	-0.3520	-0.3726
Panel C: Five- Day Event Window (Single Factor Market Model)					
	Mean	Median	SD	Min	Max
BTC CAR	-0.0906	-0.0903	0.0807	-0.2741	-0.0052
BTC+Altcoin CAAR	-0.1390	-0.1503	0.1564	-0.1650	-0.1737
Altcoin CAAR	-0.1428	-0.1542	0.1603	-0.1689	-0.1777
Pane D:Ten- Day Event Window (Single Factor Market Model)					
	Mean	Median	SD	Min	Max
BTC CAR	-0.0688	-0.0717	0.0699	-0.2727	0.0021
BTC+Altcoin CAAR	-0.0743	-0.0784	0.0830	-0.0879	-0.0927
Altcoin CAAR	-0.0748	-0.0789	0.0836	-0.0886	-0.0935

Notes: CAR = Cumulative Abnormal Returns
CAAR = Cumulative Average Abnormal Returns

5.2. Event day CAR and CAAR

Tables 2 and 3 display the CAR (BTC) and CAAR of the two groups (BTC plus Altcoins and Altcoins) for the event days -5 to +5 using the constant mean and single factor models. The BTC CAR values are positive under the constant mean model. However, the CAAR values of BTC plus Altcoins and Altcoins are negative for the -5 to +5 event days. Under the single factor model, all the three groups exhibit negative effect. None of the t-values is greater than 1.96 implying that the impact is not statistically significant at the 5% level. These results are confirmed in Graphs 1 and 2. However, Graphs 1 and 2 show that the negative impact of Covid-19 is more pronounced in the case of Altcoins

than BTC over the 5-day event window.[9] These results support hypotheses H1, H2 and H3 that Bitcoin and Altcoins are likely to be adversely impacted by Covid-19, and Altcoins are more adversely affected than Bitcoin.

Table 2: Five- Day Event Window CAR and CAAR (Covid-19 Effect) Constant Mean Return Model

Event Day	BTC CAR	T-Statistics	BTC+Altcoin CAAR	T-Statistics	Altcoin CAAR	T-Statistics
-5	0.0236	0.0310	-0.0458	-0.1999	-0.0512	-0.2232
-4	0.1181	0.1553	-0.1801	-0.7853	-0.2030	-0.8853
-3	0.1421	0.1868	-0.2041	-0.8903	-0.2308	-1.0065
-2	0.1449	0.1906	-0.2171	-0.9467	-0.2449	-1.0681
-1	0.1459	0.1918	-0.2629	-1.1465	-0.2943	-1.2836
0	0.6117	0.8044	-0.7051	-3.0751	-0.8064	-3.5168
1	0.5039	0.6626	-0.6629	-2.8912	-0.7527	-3.2827
2	0.5753	0.7566	-0.7625	-3.3253	-0.8654	-3.7742
3	0.5436	0.7149	-0.8031	-3.5024	-0.9067	-3.9542
4	0.6205	0.8160	-0.9466	-4.1283	-1.0671	-4.6540
5	0.5842	0.7682	-0.9765	-4.2591	-1.0966	-4.7827

Notes: BTC CAR = Bitcoin Cumulative Abnormal Return,
CAAR = Cumulative Average Abnormal Returns

Table 3: Five- Day Event Window CAR and CAAR (Covid-19 Effect) Single Factor Market Model

Event Day	BTC CAR	T-Statistics	BTC+Altcoin CAAR	T-Statistics	Altcoin CAAR	T-Statistics
-5	-0.0052	-0.0398	-0.0265	-0.6721	-0.0282	-0.0011
-4	-0.0394	-0.3012	-0.0952	-2.4125	-0.0995	-0.0039
-3	-0.0177	-0.1352	-0.0621	-1.5750	-0.0656	-0.0026
-2	-0.0355	-0.2711	-0.0719	-1.8223	-0.0747	-0.0029
-1	-0.0160	-0.1219	-0.0761	-1.9291	-0.0807	-0.0032
0	-0.2741	-2.0946	-0.3262	-8.2681	-0.3303	-0.0130
1	-0.0903	-0.6902	-0.1406	-3.5633	-0.1445	-0.0057
2	-0.1536	-1.1734	-0.1876	-4.7532	-0.1902	-0.0075
3	-0.1044	-0.7975	-0.1498	-3.7975	-0.1533	-0.0061
4	-0.1181	-0.9021	-0.1827	-4.6290	-0.1876	-0.0074
5	-0.1423	-1.0873	-0.2107	-5.3392	-0.2159	-0.0085

Notes: BTC CAR = Bitcoin Cumulative Abnormal Return,
CAAR = Cumulative Average Abnormal Returns

[9.] The results for the 10-day event window period, though not displayed here, show similar results.

Figure 1:Five -Day Event Window (Constant Mean Model)

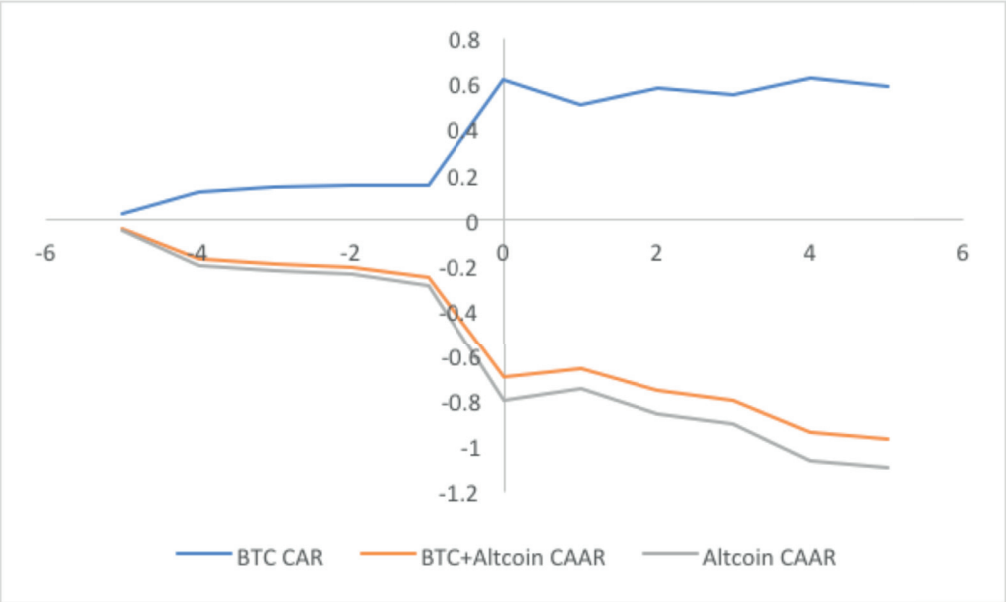
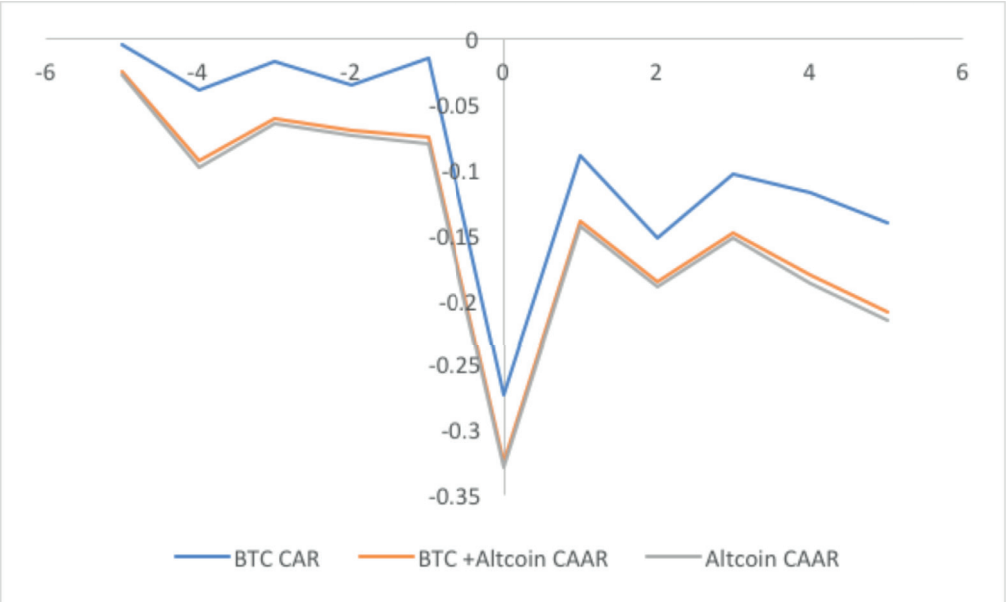


Figure 2: Five- Day Event Window (Single Factor Market Model)



5.3. Multivariate analysis (linear regression estimates)

Table 4 shows the linear regression estimates where the abnormal returns of the sampled cryptocurrencies were regressed against a set of covariates which are expected to influence the value of these currencies. The Covid-19

dummy variable takes a value of 1 for observations from the event day (11 March 2020) and 0 otherwise. Volume, crypto index returns, circulating supply, market capitalization and Covid-19 Dummy are the covariates included in the model. Except the circulating supply and Covid-19 Dummy, all the other variables are expected to exert a positive impact on cryptocurrency values. The results show that all the variables have the expected signs, however, only market capitalization and circulating supply show any significant impact as their coefficients are significant at the 1% level. The negative coefficient on the circulating supply variable implies the higher the supply the lower the value. On the contrary, the greater the value of market capitalization, the larger the likely value of cryptocurrencies. Cryptocurrencies with high market capitalization such as BTC is frequently traded on the crypto markets and they are preferred by investors. The sign of the coefficient on the Covid-19 Dummy variable is on expected line (negative), nonetheless, the impact of the pandemic appears to be insignificant. This could be because by the time the WHO declared Covid-19 as a global pandemic on 11 March 2020 (event day), the crypto market might have already discounted the effect of the pandemic.

Table 4: Linear Regression Results with Abnormal Returns (AR) as dependent variable

Variables	Coefficients	Standard Error	T-Ratio	p-value
Volume	0.1267	0.0320	3.9593	0.7150
Index-Return	0.0176	0.0170	1.0352	0.3020
Circulating Supply	-0.2210	1.0424	-0.2120	0.0090***
Market Capitalization	0.1130	0.0421	2.6840	0.00760***
COVID-19 Dummy	-0.1003	0.1025	-0.9785	0.9160
Constant	-0.0202	0.1012	-0.1996	0.8650
No of Observations	13,006			
Adjusted R^2	0.4104			

Notes: *** indicates statistical significance at the 1% level.

5.4. Bitcoin versus Altcoins (logistic regression results)

A logistic regression was estimated with BTC-ATC (Altcoins) Dummy as dependent variable, which takes a value of 1 for the BTC observations and 0 otherwise. The dummy variable was regressed against a set of covariates

which include the cryptocurrency returns, volume, circulating supply, market capitalization and the Covid-19 dummy variable. The coefficients on these variables have the expected signs, however, only three variables (Volume, Circulating Supply and COVID-19 Dummy) are statistically significant at the 1% level (see Table 5). The logistic results provide evidence of a strong negative impact of Covid-19. The coefficients on return, volume and market capitalization are positive, however, only the volume variable has any impact as its coefficient is significant at the 1% level. The coefficients on circulating supply and Covid-19 Dummy are negative as expected, and Altcoins are more adversely affected than Bitcoin, supporting H3.

Table 5: Logistic regression with the BTC-ATC dummy variable as dependent variable

Variables	**Coefficients**	**Standard Error**	**T-Ratio**	**p-value**
Return	0.2144	0.4545	0.4717	0.6370
Volume	0.0546	0.0278	1.9640	0.0000***
Circulating Supply	-0.5231	0.3461	-1.5114	0.0290***
Market Capitalization	0.4530	0.3234	1.4007	0.7890
COVID-19 Dummy	-1.3761	1.3321	-1.0330	0.0000***
Constant	-0.2274	1.2499	-0.18193	0.0000***
No of Observations	13,006			
Chi-Square	5643.8700	P-value	0.0000***	
Log likelihood	-524.7508			
Pseudo R^2	0.6432			

Notes: *** indicates statistical significance at the 1% level.

BTC = Bitcoin and ATC = Altcoins.

5.5. Robustness test results (Propensity Score Marching)

As a robustness test, the propensity score matching technique was employed to create a balanced dataset to make a direct comparison between the pre and the post Covid-19 values of the sampled cryptocurrencies. The aim was to eliminate a greater portion of selection bias when estimating the impact of Covid-19. Table 6 presents the Average Treatment Effect (ATE) of Covid-19 on cryptocurrency values using a logistic treatment model. Two models have been estimated with the former excluding abnormal returns in covariates and the latter making an inclusion of abnormal returns. The results of the first model presented in Panel

A (Table 6) show that Covid-19 has caused an average reduction of 3% in the value of cryptocurrencies, however, the Z-statistics is not significant implying the impact was negative but not effective. Panel B (Table 6) shows the results where the cryptocurrency value is reduced by an average of 4% and the negative impact is effective as the Z-statistic is significant at the 1% level. This better result is achieved when the abnormal returns from the event study estimation were included in the model as one of the covariates.

Table 6: Average Treatment Effect (Propensity Score Matching)

Panel A: Model 1				
ATE	**Coefficient**	**SE**	**z**	**p-value**
COVID-19 Dummy (1 vs 0)	-0.0288	1.0925	-0.0264	0.9790
Panel B: Model 2				
ATE	**Coefficient**	**SE**	**z**	**p-value**
COVID-19 Dummy (1 vs 0)	-0.0376	0.0026	14.2850	0.000***
Outcome Variable: Value of Cryptocurrencies				
Number of Observations: 13,006				
Treatment Variable: COVID-19 Dummy				
Treatment Model: Logit				
Covariates (Model 1) Volume, Calculating Supply, Market Capitalization				
Covariates (Model 2) Volume, Calculating Supply, Market Capitalization, Abnormal Returns				

Notes: *** indicates statistical significance at the 1% level.

5.6. Practical implications

Since the pandemic outbreak, the price of Bitcoin declined below $4000 after the S&P index in the U.S.A registered a sharp decline showing a correlation between Bitcoin and equities market. A possible reason for this could be the attempt of investors to cover the margin calls in equity by liquidating Bitcoin into cash. There are also accounting issues as cryptocurrencies do not fit into an existing accounting framework. Since cryptocurrencies are digital coins lacking physical substance, they could be considered as intangible assets. Given the Covid-19 scenario with significant volatility in crypto market, there are practical accounting challenges including when to test cryptocurrencies (intangible assets) for impairments.

6. Conclusion

The aim of the present study is to examine the impact of Covid-19 using a select sample of cryptocurrencies including Bitcoin, the market leader. Having obtained the abnormal returns using the event study method, a linear regression was estimated by regressing the abnormal returns against a set of covariates including Volume, Circulating Supply, Market Capitalization, and the Covid-19 Dummy variable. To ascertain whether Covid-19 has had any differential impact on Bitcoin (BTC) and Altcoins (ATCs), a logistic regression was estimated using BTC-ATC Dummy as the dependent variable. Both the event study and the regression estimates, on average, show that Covid-19 has a negative impact on the value of the sampled cryptocurrencies. However, the results, by and large, do not provide enough evidence to conclude that the negative effect is significant. The propensity scores matching results show that when abnormal returns are included as one of the covariates, there is a marked improvement in results showing a significant negative impact of Covid-19.

Biographical notes

Mathew Abraham holds a PhD in Finance from the University of Auckland, and he is currently a Senior Lecturer in Finance at Whitireia Business School (a New Zealand Government Institute of Technology), Wellington. Mathew has recently developed research interest in blockchain technology and his research areas include equity market, tax imputation, crypto market and financial econometrics. He has publications in the areas of equity market and cryptocurrency, and he is also a financial analyst.

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