DIGITALES ARCHIV

ZBW – Leibniz-Informationszentrum Wirtschaft ZBW – Leibniz Information Centre for Economics

Anandhabalaji, V.; Babu, Manivannan; Gayathri, J. et al.

Article

Examining the volatility of conventional cryptocurrencies and sustainable cryptocurrency during Covid-19 : based on energy consumption

International Journal of Energy Economics and Policy

Provided in Cooperation with: International Journal of Energy Economics and Policy (IJEEP)

Reference: Anandhabalaji, V./Babu, Manivannan et. al. (2023). Examining the volatility of conventional cryptocurrencies and sustainable cryptocurrency during Covid-19 : based on energy consumption. In: International Journal of Energy Economics and Policy 13 (6), S. 344 - 352. https://www.econjournals.com/index.php/ijeep/article/download/14972/7572/35029. doi:10.32479/ijeep.14972.

This Version is available at: http://hdl.handle.net/11159/631379

Kontakt/Contact ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics Düsternbrooker Weg 120 24105 Kiel (Germany) E-Mail: *rights[at]zbw.eu* https://www.zbw.eu/

Standard-Nutzungsbedingungen:

Dieses Dokument darf zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden. Sie dürfen dieses Dokument nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, aufführen, vertreiben oder anderweitig nutzen. Sofern für das Dokument eine Open-Content-Lizenz verwendet wurde, so gelten abweichend von diesen Nutzungsbedingungen die in der Lizenz gewährten Nutzungsrechte. Alle auf diesem Vorblatt angegebenen Informationen einschließlich der Rechteinformationen (z.B. Nennung einer Creative Commons Lizenz) wurden automatisch generiert und müssen durch Nutzer:innen vor einer Nachnutzung sorgfältig überprüft werden. Die Lizenzangaben stammen aus Publikationsmetadaten und können Fehler oder Ungenauigkeiten enthalten.



κ'ΗΠ

https://savearchive.zbw.eu/termsofuse

Terms of use:

This document may be saved and copied for your personal and scholarly purposes. You are not to copy it for public or commercial purposes, to exhibit the document in public, to perform, distribute or otherwise use the document in public. If the document is made available under a Creative Commons Licence you may exercise further usage rights as specified in the licence. All information provided on this publication cover sheet, including copyright details (e.g. indication of a Creative Commons license), was automatically generated and must be carefully reviewed by users prior to reuse. The license information is derived from publication metadata and may contain errors or inaccuracies.



Leibniz-Informationszentrum Wirtschaft Leibniz Information Centre for Economics



INTERNATIONAL JOURNAL O ENERGY ECONOMICS AND POLIC International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http://www.econjournals.com

International Journal of Energy Economics and Policy, 2023, 13(6), 344-352.



Examining the Volatility of Conventional Cryptocurrencies and Sustainable Cryptocurrency during Covid-19: Based on Energy Consumption

V. Anandhabalaji¹, Manivannan Babu¹*, J. Gayathri², J. Sathya³, G. Indhumathi⁴, R. Brintha¹, Justin Nelson Michael⁵

¹Research Scholar, Bharathidasan School of Management, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India, ²Department of Commerce and Financial Studies, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India, ³Sri Sarada College for Women, India, ⁴Mother Teresa Women's University, India, ⁵School of management, Kristu Jayanti College, Autonomous, Bengalur, India. *Email: drbabu@bdu.ac.in

Received: 28 July 2023

Accepted: 16 October 2023

DOI: https://doi.org/10.32479/ijeep.14972

ABSTRACT

The present study proposes to investigate the influence of the covid-19, on the adjusted closing price of the digital currency based on energy consumption during the process of mining. The study employed the secondary data analysis of top ten market capitalization of cryptocurrencies with the combination of high energy consume mechanism (proof of work) and low energy consume mechanism (proof of stake). Statistical tools like Descriptive analysis, Augmented Dickey-Fuller (ADF) test, ARCH, and GARCH models were used in the study. The present study finds that the prices of cryptocurrencies were highly volatile. This study could assist investors towards better understanding of the dynamics of the cryptocurrency market based on energy consumption which helps them to make more effective decisions, on investing cryptocurrencies with a scientific approach.

Keywords: Cryptocurrency, Volatility, Covid-19, Sustainability, GARCH JEL Classifications: F36, G01, G15, L72, Q42

1. INTRODUCTION

Cryptocurrency is estimable as a remittance and back-and-forth currency (Livieris et al., 2021), global phenomenon has evolved around cryptocurrencies in the financial sectors (Chowdhury et al., 2020). Bitcoin was the first cryptocurrency to be decentralized (Sarkodie, 2022). Bitcoin is not universally recognized by the government and other international organizations, despite its appeal as a form of payment (de la Horra et al., 2020). There is a lot of disputes among academics over whether cryptocurrencies should be classified as money or an investment (Yuneline, 2019). Cryptocurrency price remains difficult to predict since they are highly volatile (Guo et al., 2021). But investments in cryptocurrency are considered to be one of the most popular types of investment (Livieris et al., 2021). Investors increasingly incorporate cryptocurrencies into their portfolio even though they were not originally designed for the investment purpose (Inci and Lagasse, 2019). Investors, regulators, and the general public are interested in cryptocurrencies due to their popularity and it also attracted negative attention, especially in the investment sector (Giudici et al., 2019). Investors can maximize investing selections depending on the market fear emotion in the face of extreme global uncertainty and fluctuating market sentiment (Chi-Wei SU, 2022; Valencia et al., 2019). In low-trust and high-uncertainty settings, investors switch from fiat money to Cryptocurrencies (Jin et al., 2021). The biggest challenges in adoption of cryptocurrency, it is

This Journal is licensed under a Creative Commons Attribution 4.0 International License

harmful to the environment by emit carbon and it consumes more energies, the energy source is non-renewable energy (Carter, 2021).

1.1. Cryptocurrency Energy Consumption

Bitcoin alone consumes 707KwH per transaction to maintain stability of the device and it emits large amount of carbon (Yuan et al., 2022). Even the cooling system differ from device to device, hence the energy consumption level varies from one device to another as per the study of University of Cambridge (Sarkodie and Owusu, 2022). Bitcoin consumes more than 121-terawatt hour a year which is the combined total energy consumption level of Google, Apple, Facebook and Microsoft (Valeonti et al., 2021). Proof-of-work is the protocol used to generate new coin and make the transaction successfully in the network by using high amount of non-renewable energy. Even proof-of-work has security threats (Shi, 2016). USA has the world's largest crypto mining industry in the world which consume 38% of global bitcoin function (Hossain, 2021) which is equal to 0.9-1.7% of total country energy consumption that is equal to diesel fuel emission of railroad in US (House, 2022).

- The annual power consumption of bitcoin in the year 2017 is 6.6 terawatt-hours to the 138 terawatt-hours in 2022 (Ante and Fiedler, 2021)
- The maximum life span of mining computers are 1.5 years and which are not recyclable and it generates 11.5 kilotons of e-wastes every year (De Vries, 2019).

Here proof of stake is the alternative technology which consume lesser energy while compare with proof of work (Ethereum, 2023). To validate the transaction, proof of work consumes large amount of energy to maintain the operation. Even though proof of work is slowest process to complete a task while compare with other mechanism. Based on recent study, 70% of electricity consume for bitcoin is came from Chinese Hydroelectricity in 2019 (IvanOnTech, 2022). The whole mining process is depended on the computation power and 51% attack malicious block. In other hand proof of stake required low energy level and 51% attack is impossible (Saad and Radzi, 2020).

1.2. Crypto Mining

Mining is the process of generating new coin and circulating it into the market, the network also confirming each transaction of cryptocurrency (Li et al., 2019; Naeem et al., 2021). It required high specification hardware, software and other sophisticated equipment to make the process smooth (Naeem et al., 2021). The life span of the hardware computers are approximately 1.5 years so it leads to E-Waste (Calvão, 2019; Livieris et al., 2020). While doing the mining process, the miner will get reward for generating new tokens and approving each transaction. Due to the verification of transaction, it controls double spending issues (Shuaib et al., 2022). First miner who resolved the complicated arithmetical problems get rewards. The whole process is called proof of work (Schinckus, 2021). The alternative source for the proof of work (Schinckus, spiroof of stake which consumes less energy. Ethereum is the best example for the proof of stake (Kiayias et al., 2017).

1.3. Technological Aspect

The cryptocurrency sector has exploded in popularity since the introduction of Bitcoin and other blockchain-based peer-to-peer

payment networks (Zhang, 2021). All operations and ownerships within Bitcoin system are recorded on the distributed ledger (Thazhungal Govindan Nair, 2021). This peer-to-peer network stores a backup of the ledger entry on each node (Ethereum community). The network dismisses all hashes in a branch except for the root hash contained in the block header when the operations are merged into a block and this block is confirmed (Mikołajewicz-Woźniak et al., 2015). Bitcoin implemented Simplified Payment Verification (SPV), which requires nodes to store only a duplicate of the longest chain's transaction headers, rather than a complete record of transactions (Squarepants, 2008; Khalid Salman et al., 2020). However, these systems necessitated the involvement of a trusted third party (Susana et al., 2020). In a centralized solution, banks or even other trust-worthy governing bodies can prevent attempts to issue at the same time decentralized system, such as cryptocurrency, this issue is critical (Tschorsch et al., 2016). Here cryptocurrencies have unique blockchain technology that distinguishes them from traditional assets (Conlon et al., 2020).

1.4. Cryptocurrency Market during Covid-19

Traditional financial investments like stock, had faced the crisis during the period of Covid-19 (Marobhe, 2022). The price relationship between Bitcoin, stock, gold, and oil markets is generally minimal, but during the COVID-19 period, it became higher (Hung, 2021; Bandhu Majumder S, 2022). Following that the Federal Reserve implemented many monetary policies to mitigate the pandemic's impact on stock markets, resulting in a misconception about the cryptocurrency market's reaction (Mnif and Jarboui, 2021). The volatility series of cryptocurrencies have shown a surprising degree of endurance in comparison to global stock markets during the COVID-19 (Lahmiri and Bekiros, 2021; Corbet et al., 2022). During the massive economic crisis brought by the COVID-19 pandemic, BTC sparked significant attention (Corbet et al., 2020). The COVID-19 outbreak is a once-in-alifetime occurrence that has slowed the global economy in every industry (Sohrabi et al., 2020; Guzmán et al., 2021; Mnif et al., 2020). This spike in Bitcoin prices, which occurred during the COVID-19 epidemic, has been associated with a substantial body of research on whether cryptocurrency, particularly bitcoin, used as a haven during times of instability (Huynh et al., 2020; Lahmiri et al., 2020). The cryptocurrency market is an excellent opportunity to diversify and hedge your portfolio even in the face of pandemics like COVID-19 (Karim et al., 2022; Shao et al., 2021). To understand the market volatility of energy sector, ARCH and GARCH (1, 1) were examined (Babu, et al., 2022). To understand the market volatility of stock market indices GARCH (1, 1) found the volatility of Indian market (Babu et al., 2023).

1.5. Cryptocurrency Market Volatility

The extreme volatility of cryptocurrency value necessitates the development of an accurate model to forecast its value (Khedr et al., 2021; Kaya et al., 2021). Compared to the stock market; the crypto market is significantly more volatile (Bouri et al., 2020; Equity against the Odds, 2018). During times of regional price fluctuations and significant systemic events, user behavior in the bitcoin and Ethereum markets is strikingly different (Aspembitova et al., 2021). Due to the inability to place an accurate value on cryptocurrencies such as Bitcoin, their volatility is the biggest

problem (Smales, 2019). Because of the large number of cryptocurrencies available, the crypto market is complex and dangerous, with frequent and significant price fluctuations (Bouri et al., 2019; Ftiti et al., 2021). Cryptocurrencies have prompted a debate about analyzing the dangers connected with their control, through technological advance (Dudukalov et al., 2021). Cryptocurrency marketplaces have been hurt by market volatility and threats (El-Berawi et al., 2021).

According to Gallersdörfer et al. (2020), bitcoin consume more energy which affect the environment drastically but the study does not focus on sustainable cryptocurrencies. Hence this study analyzes the combination of conventional cryptocurrency as well as sustainable cryptocurrency by examine the market volatility of the sampled cryptocurrency. Hence, the study was attempted to analyze the market volatility for top ten cryptocurrencies based on energy consumption level. To understand the volatility of the market during Covid-19, Descriptive Statistics, ADF Test and GARCH (1,1) Model were used for the study (Babu et al., 2022). Finally, Babu and Srinivasan (2014) selected ten commodities to analyze the volatility of commodity market.

2. THEORETICAL DEVELOPMENT

The motivational, attitudinal, and self-efficacy elements of numerous theories are included in the health belief model. The theories of planned behavior (TPB) and theories reasoned action (TRA), proposed by Ajzen in 1985 and 1991, respectively. As precise indicators of behavioural intentions toward investment, Fishbein and Ajzen 1975 consider the individual's attitude and social norms as well as the individual's perception of control. TRA and TPB are the main metrics to measure investor behavior towards developing investment instruments like bitcoin. TRA is most effective when used to activities that are under an individual's voluntary control. As a result, present study uses the TRA and TPB theories to assess how the cryptocurrency markets' pricing behavior would affect COVID-19. The present study examines the effects of the covid-19 pandemic on cryptocurrency markets.

3. METHODOLOGY

3.1. Null Hypotheses of the Study

- NH01: The conventional cryptocurrency and sustainable cryptocurrency returns are not normally distributed
- NH02: The conventional cryptocurrency and sustainable cryptocurrencyreturns are not stationary
- NH03: There is no correlation among the conventional cryptocurrency and sustainable cryptocurrency returns
- NH04: There is no volatility among the conventional cryptocurrency and sustainable cryptocurrency returns.

3.2. Data Variables and Data Sources

COVID-19 received its first formal confirmation on December 31, 2019 in Wuhan (AlTakarli, 2022). In this study, cryptocurrencies were selected based on the highest market capitalization of the cryptocurrencies during the covid-19 pandemic period from

November 01, 2019 to March 01, 2022. Thedetails of the Market Capitalization of cryptocurrencies are presented in Table 1. Here Solana, Avalanche and Polkadot were not selected for the analysis because complete daily adjusted closing price data were not available for the specified period. In this study, Binance coin, Binance USD, Bitcoin, Ethereum, Cardano, Dogecoin, and Terra, Tether, USD Coin, and XRP were used as the sample.

The aim of the study is to analyses the market volatility of conventional cryptocurrency (consume more energy) and sustainable cryptocurrencies (eco-friendly) based on energy consumption. Under proof of work Bitcoin, Tether, Usd coin (stable coin) and Dogecoin which consumes more energy especially nonrenewable energy. Proof of stake is the concept of eco-friendly cryptocurrencies which generate by using low energy as well as renewable energy for mining process which are Ethereum, Binance coin, Cardano, Terra and Binance Usd (stable coin). Xrp coin is based on RPCA concept which generate coin without mining activities. Figure 1 shows that division of Conventional Cryptocurrency and Sustainable Cryptocurrency based on Energy Consumption.

- Low Energy consumption while during mining process-Ethereum, Binance coin, Cardano, Terra and Binance Usd (stable coin)
- High Energy consumption while during mining process-Bitcoin, Tether, Usd coin (stable coin) and Dogecoin
- No mining process-Xrp coin.

4. EMPIRICAL RESULTS

This section discusses the price fluctuation of the highest market capitalization of cryptocurrencies, by using Descriptive analysis, Augmented Dickey-Fuller Test, Correlation analysis, and GARCH (1,1) Model.

4.1. Descriptive analysis for the Sample Cryptocurrencies Return

The data for the daily adjusted closing price of the cryptocurrencies were collected from Yahoo Finance and Coin Market Capital. The overall sample period began in November 2019 and ended in March 2022, which recorded 852 daily observations for the cryptocurrencies. This study mainly focused on the daily price fluctuation of cryptocurrencies during the study period. It is clear from the Table 2 that the descriptive analysis of the topmost market capitalization of cryptocurrencies, Tether and Binance USD, had reported the highest average returns of -0.0000231 and -0.0000278 respectively. Dogecoin and Terra USD had recorded the lowest average returns, at -0.010054 and -0.009408, respectively. The maximum returns were reported by Bitcoin and Ethereum, with 1 and 0.423 respectively and the minimum returns were reported by Dogecoin and Terra USD, with -3.55 and -0.887 respectively. Only Bitcoin and Ethereum's return distributions were positively skewness, with 8.68 and 0.532 respectively. Binance coin, Binance USD, Cardano, Dogecoin, Terra, Tether, USD coin, and XRP coin, were the eight cryptocurrencies, which were negatively skewed. The normal distribution of 10 cryptocurrencies was examined by using (Jarque-Bera [J-B]), and the results indicated that they were all normally distributed Anandhabalaji, et al.: Examining the Volatility of Conventional Cryptocurrencies and Sustainable Cryptocurrency during Covid-19: Based on Energy Consumption

Table 1: Market capitalization of	f cryptocurrencies
-----------------------------------	--------------------

S. No.	Cryptocurrencies	Ticker	Initial issue November 2019	Market capitalization (US\$)
1	Bitcoin (high energy consumption)	BTC	May 2010	US\$813,929,628,581
2	Ethereum (low energy consumption)	ETH	July 2015	US\$363,960,604,012
3	Tether (high energy consumption)	USDT	October 2014	US\$80,714,727,098
4	Binance coin (low energy consumption)	BNB	July 2017	US\$68,873,171,909
5	USD coin (high energy consumption)	USDC	September 2018	US\$52,335,073,752
6	Solana	SOL	April 2020	US\$39,808,659,990
7	XRP (no mining process)	XRP	June 2012	US\$40,050,396,160
8	Cardano (low energy consumption)	ADA	September 2017	US\$36,920,648,824
9	Terra (low energy consumption)	LUNA	January 2018	US\$33,477,626,915
10	Avalanche	AVAX	September 2020	US\$23,860,330,505
11	Polkadot	DOT	May 2020	US\$20,267,358,578
12	Dogecoin (high energy consumption)	DOGE	December 2013	US\$18,099,678,873
13	Binance USD (low energy consumption)	BUSD	July 2017	US\$17,619,649,515

Source: YahooFinance and CoinMarketCapital

Table 2: Result of normality distribution for cryptocurrencies based on energy consumption

Measures	Bitcoin	Ethereum	Tether	Binance coin	USD coin	XRP	Cardano	Terra	Dogecoin	Binance
										USD
Mean	-0.001420	-0.004505	0.0000231	-0.005232	0.0000368	-0.003276	-0.005549	-0.009408	-0.010054	0.0000278
Median	-0.001425	-0.003902	0.000010	-0.002164	0.0000240	-0.001597	-0.002090	-0.000179	0.000376	0.000000
Maximum	1.0	0.423089	0.038453	0.419098	0.030503	0.422720	0.395337	0.385117	0.397987	0.053576
Minimum	-0.187677	-0.259513	-0.054657	-0.697126	-0.042863	-0.560308	-0.322323	-0.887508	-3.556075	-0.054925
SD	0.051899	0.051057	0.003731	0.061531	0.003854	0.067450	0.060903	0.087279	0.148765	0.003988
Skewness	8.680641	0.532927	-2.757743	-1.678037	-1.993288	-1.355380	-0.393528	-2.241093	-16.64952	-0.617489
Kurtosis	167.5281	11.42553	78.25791	27.67572	40.18514	17.57087	7.633684	20.78609	384.3612	89.38323
Jarque-Bera	971,666.7	2560.457	202,143.2	22,015.48	49,651.28	7797.876	784.2121	11,943.44	5202356.	264,957.4
Probability	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Sum	-1.210127	-3.838120	-0.019658	-4.457278	-0.031334	-2.791209	-4.727739	-8.015645	-8.566350	-0.023663
Sum square	2.292136	2.218433	-0.019658	3.221938	0.012640	3.871620	3.156537	6.482637	18.83347	0.013537
deviation										
Observations	852	852	852	852	852	852	852	852	852	852

SD: Standard deviation

Figure 1: Division of Conventional Cryptocurrency and Sustainable Cryptocurrency based on Energy Consumption



Source: Design by author

during the study period. Hence, (NH01), the conventional cryptocurrency and sustainable cryptocurrencyreturns are not normally distributed was rejected. The graphical representation of the daily time-series data of the selected cryptocurrencies is presented in Figure 2.

4.2. Stationarity Test for the Sample Cryptocurrencies Return

Table 3 shows the results of summary result of the ADF test for the daily adjusted closing price of the cryptocurrencies, during the study period from November 2019 to March 2022. According to Table that, the P-values, for all the sample variables, were zero. The statistical values, for all ten cryptocurrencies values, were –26.3 (BITCOIN), –31.7 (Ethereum), –19.3 (Tether), –18.8 (Binance Coin), –11.3 (USD Coin), –29.4 (XRP), –31.2 (Cardano), –30.0 (Terra), –28.9 (Dogecoin), –13.1 (Binance USD), at 1%, 5%, and 10%. Throughout the study period, the actual values of the t statistic test for cryptocurrencies were lower than the actual values of the critical test value. The overall analysis of ADF test clearly exhibit that, there was stationarity in the cryptocurrency returns during the study period. Hence, the Null Hypothesis (NH02), the conventional cryptocurrency and sustainable cryptocurrency returns are not stationarity, was not accepted.

4.3. Correlation Analysis for the Sample Cryptocurrencies Return

The degree of correlation between the base mean returns was determined by using linear regressions, to obtain the Pearson correlation. Table 4 clearly shows the results of this correlation for the COVID-19 timeframe. The study demonstrated that bitcoin and other cryptocurrencies did have positive relationship except for Tether and the USD coin which reported negative relationship, with a value of -0.12 and -0.056, respectively. It means that when the value of bitcoin would increase by 100%, the value of the USD coin would go down by 5.6% and the value of Tether would go down by 12.4%. Ethereum and bitcoin had demonstrated positive relationship with bitcoin, with value of 59.5% and 48.2% respectively. This indicated that when bitcoin price went up by 100%, Ethereum and Binance coins would go up by 59.5% and 48.2% respectively. The graphical representations of the daily adjusted closing price of cryptocurrency daily price fluctuations of the cryptocurrencies are shown in Figure 3. The Table shows that, with the exception of Tether and USD Coin, there was a statistically significant positive association between the sample cryptocurrencies during the study period. Hence the null hypothesis (NH03): There is no Correlation among the conventional cryptocurrency and sustainable cryptocurrency return, was partially accepted.





Source: computed by using E-views

Table 3: The result shows that the Augmented Dickey-fuller test for cryptocurrencies from November 2019 to March 2022

Cryptocurrency	Statistical value	1%	5%	10%	Probability
Bitcoin	-26.26368	-3.437810	-2.864722	-2.568518	0.0000
Ethereum	-31.75215	-3.437810	-2.864722	-2.568518	0.0000
Tether	-19.37778	-3.437865	-2.864746	-2.568531	0.0000
Binance coin	-18.84313	-3.437819	-2.864726	-2.568521	0.0000
USD coin	-11.33946	-3.437892	-2.864759	-2.564759	0.0000
XRP	-29.47320	-3.437810	-2.864722	-2.568518	0.0000
Cardano	-31.22339	-3.437810	-2.864722	-2.568518	0.0000
Terra	-30.05179	-3.437810	-2.864722	-2.568518	0.0000
Dogecoin	-28.98646	-3.437810	-2.864722	-2.568518	0.0000
Binance USD	-13.14579	-3.437929	-2.864775	-2.568547	0.0000



Figure 3: Graphical representation of price fluctuation of ten cryptocurrencies during a pandemic outbreak

Source: Computed by using E-views

Table 4: Result of correlation analysis of cryptocurrencies during pandemic period

Variables	Bitcoin	Ethereum	Tether	Binance	USD coin	XRP	Cardano	Terra	Doge coin	Binance
				coin						USD
Bitcoin	1									
Ethereum	0.59560525	1								
Tether	-0.1247986	-0.1794165	1							
Binance	0.48290686	0.67866509	-0.1301379	1						
coin										
USD coin	-0.0569599	-0.0909717	0.76320813	-0.0595483	1					
XRP	0.41599187	0.59454357	-0.1024021	0.51551381	-0.0554725	1				
Cardano	0.48189085	0.70673441	-0.1369162	0.58752297	-0.0606518	0.54251569	1			
Terra	0.34699948	0.44844138	-0.0137030	0.40245781	-0.0169865	0.33122583	0.37148753	1		
Dogecoin	0.24042391	0.26143189	-0.0429964	0.17772815	-0.0232528	0.19901772	0.25796386	0.21118962	1	
Binance	-0.1662094	-0.2284240	0.91240250	-0.1602449	0.76866129	-0.1336926	-0.1844017	-0.0252709	-0.0525775	1
USD										

Table 5: The result of the GARCH model for highest market capitalization of cryptocurrencies

Cryptocurrency	С	α	β	α+β
Bitcoin	0.0002	0.4209	0.6744	1.0952
Ethereum	0.0001	0.0757	0.8961	0.9718
Tether	0.0000	0.5036	0.6752	1.1788
Binance coin	0.0001	0.1614	0.8307	0.9921
USD coin	0.0000	0.3788	0.7207	1.0996
XRP	0.0004	0.7179	0.4916	1.2095
Cardano	0.0002	0.1243	0.8207	0.9450
Terra	0.0004	0.1785	0.7910	0.9695
Dogecoin	0.0012	5.2207	0.0072	5.2278
Binance USD	0.0000	0.4992	0.6678	1.1670

4.4. GARCH (1, 1) Model for the Selected Cryptocurrencies

Table 5 displays the results of the GARCH (1,1) model for the daily returns of sample cryptocurrency returns from November

2019 to March 2022. It is to be noted that the values ($\alpha + \beta$) of cryptocurrencies were 1.0952 (Bitcoin), 0.9718 (Ethereum), 1.1788 (Tether), 0.9921 (Binance Coin), 1.0996 (USD Coin), 1.2095 (XRP), 0.9450 (Cardano), 0.9695 (Terra), 5.2278 (Dogecoin), 1.1670 (BinanceUsd). The results of GARCH (1, 1) Model revealed that, the Dogecoin (5.2278) was highly volatile, followed by XRP (1.2095), Tether (1.1788), Binance Usd (1.167), USD Coin (1.0996), Bitcoin (1.0952), Binance Coin (0.9921), Ethereum (0.9718), Terra (0.9695), and Cardano (0.945), during the study period. The GARCH Model research revealed that the $\alpha + \beta$ values of all ten cryptocurrencies were close to one. This demonstrated that the returns data for all ten cryptocurrencies' prices were extremely volatile over the study period. Thus the null hypothesis (NH04), there is no volatility among the conventional cryptocurrency and sustainable cryptocurrency return, was rejected.

During COVID-19, the theories of reasoned action (TRA) and theory of planned behaviour (TPB) were employed for study

in prediction to measure the impact of price behaviour of cryptocurrency marketplaces. Empirical research (e.g., Armitage and Talibudeen, 2010; Doll and Ajzen, 1992) and a meta-analysis have all validated the efficacy of the TPB and TRA (Armitage and Conner, 2001). Doll and Ajzen (1992) discovered that direct experience with a behaviour leads to an increase in investment preference. The current study is one of the first to examine the market movement of popular cryptocurrencies such as Bitcoin, Ethereum, Tether, Binance Coin, USD Coin, XRP, Cardano, Terra, Dogecoin, and BinanceUSD during COVID-19. As a result, the aforesaid theoretical advances are achieved by this research work.

5. CONCLUSION

This paper examined the market movement of the top cryptocurrencies like Binance coin, Binance USD, Bitcoin, Ethereum, Cardano, Dogecoin, and Terra, Tether, USD Coin, and XRP based on energy conventional cryptocurrency and energy sustainable cryptocurrency. The top ten market capitalized cryptocurrencies are combination of high energy consume mechanism (proof of work) and low energy consume mechanism (proof of stake). Even there are zero energy consume mechanism cryptocurrencies are available in the crypto market but the market capitalization and the return value is low. Hence this study does not consider the zero energy consume cryptocurrency, also known as green cryptocurrency. The Descriptive Statistics, Unit root test, Correlation, and GARCH were used to test the price movements of the top ten Cryptocurrencies. The normality test revealed that all the sample cryptocurrencies were normally distributed. Furthermore, the results of the Unit root tests demonstrated that the sample variables had attained stationarity.

During the COVID-19 period, the present study proved that there was positive relationship between the cryptocurrency returns series except for Tether and USD Coin. The results of the GARCH (1,1) Model revealed that the Dogecoin (5.2278) was highly volatile, followed by XRP (1.2095), Tether (1.1788), BinanceUSD (1.167), USD Coin (1.0996), Bitcoin (1.0952), Binance Coin (0.9921), Ethereum (0.9718), Terra (0.9695) and Cardano (0.945). As per the result of GARCH (1, 1) model, the low energy consuming cryptocurrency Cardona is not highly fluctuated cryptocurrency while compare with the high energy consuming cryptocurrencies like Dogecoin and XRP are highly fluctuating cryptocurrency.

Based on the result, the study suggests the investor to consider Cardano in the investment portfolio. During the study period with asymmetric relationship among the sample cryptocurrencies, investors are advertising to craft better investment strategies while making investment decisions in the cryptocurrency investments. The present study would also help the investors to make better investment strategies. For further study, researcher can do market research on green cryptocurrency.

REFERENCES

Ajzen, I., Fishbein, M. (1975), A Bayesian analysis of attribution processes. Psychological Bulletin, 82(2), 261.

- AlTakarli, N.S. (2020), China's response to the COVID-19 outbreak: A model for epidemic preparedness and management. Dubai Medical Journal, 3, 44-49.
- Armitage, C.J., Talibudeen, L. (2010), Test of a brief theory of planned behaviour-based intervention to promote adolescent safe sex intentions. British Journal of Psychology, 101(1), 155-172.
- Ante, L., Fiedler, I. (2021), Bitcoin's Energy Consumption and Social Costs in Relation to Its Capacity as a Settlement Layer.
- Aspembitova, A.T., Feng, L., Chew, L.Y. (2021), Behavioral structure of users in cryptocurrency market. PLOS ONE, 16(1), e0242600.
- Babu, M., Hariharan, C., Srinivasan, S., Shimny, P.S.S., Jayapal, G., Indhumathi, G., Sathya, J., Rajendran, B., Anandhabalaji, V., Kathiravan, C. (2023), Return and volatility spillovers of Asian Pacific stock markets' energy indices. International Journal of Energy Economics and Policy, 13(1), 61-66.
- Babu, M., Lourdesraj, A.A., Hariharan, C., Gayathri, J., Butani, C., Kathiravan, C. (2022), Impact of Covid-19 pandemic on environmental, social, and governance index in India. IOP Conference Series, 1057(1), 012017.
- Babu, M., Lourdesraj, A.A., Hariharan, C., Jayapal, G., Indhumathi, G., Sathya, J., Kathiravan, C. (2022), Dynamics of volatility spillover between energy and environmental, social and sustainable indices. International Journal of Energy Economics and Policy, 12(6), 50-55.
- Babu, M.M., Srinivasan, S. (2014), Testing the co-integration in Indian commodity markets: A study with reference to multi commodity exchange India Ltd. Indian Journal of Finance, 8, 35-43.
- Babu, N.D.N., Lourdesraj, A.A., Jayapal, G., Indhumathi, G., Sathya, J. (2022), Effect of COVID-19 pandemic on NSE nifty energy index. International Journal of Energy Economics and Policy, 12(4), 141-145.
- Bandhu Majumder, S. (2022), Searching for hedging and safe haven assets for Indian equity market-a comparison between gold, cryptocurrency and commodities. Indian Growth and Development Review, 15(1), 60-84.
- Bouri, E., Roubaud, D., Shahzad, S. (2020), Do Bitcoin and other cryptocurrencies jump together? The Quarterly Review of Economics and Finance, 76, 396-409.
- Bouri, E., Shahzad, S.J.H., Roubaud, D. (2019), Co-explosivity in the cryptocurrency market. Finance Research Letters, 29, 178-183.
- Calvao, F., Gronwald, V. (2019), Blockchain in the Mining Industry: Implications for Sustainable Development in Africa. South Africa: South African Institute of International Affairs (SAIIA).
- Carter, N. (2021), How Much Energy Does Bitcoin Actually Consume? Harvard Business Review. Available from: https://hbr.org/2021/05/ how-much-energy-does-bitcoin-actually-consume
- Chowdhury, R., Rahman, M.A., Rahman, M. S., Mahdy, M. (2020), An approach to predict and forecast the price of constituents and index of cryptocurrency using machine learning. Physica A: Statistical Mechanics and Its Applications, 551, 124569.
- Conlon, T., Corbet, S., McGee, R.J. (2020), Are cryptocurrencies a safe haven for equity markets? An international perspective from the COVID-19 pandemic. Research in International Business and Finance, 54, 101248.
- Corbet, S., Hou, Y.G., Hu, Y., Larkin, C., Lucey, B., Oxley, L. (2022), Cryptocurrency liquidity and volatility interrelationships during the COVID-19 pandemic. Finance Research Letters, 45, 102137.
- Corbet, S., Hou, Y.G., Hu, Y., Larkin, C., Oxley, L. (2020), Any port in a storm: Cryptocurrency safe-havens during the COVID-19 pandemic. Economics Letters, 194, 109377.
- De la Horra, L.P., de la Fuente, G., Perote, J. (2019), The drivers of Bitcoin demand: A short and long-run analysis. International Review of Financial Analysis, 62, 21-34.
- De Vries, A.H. (2019), Renewable energy will not solve Bitcoin's sustainability problem. Joule, 3(4), 893-898.

Doll, J., Ajzen, I. (1992), Accessibility and stability of predictors in the theory of planned behavior. Journal of Personality and Social Psychology, 63(5), 754.

- Dudukalov, E.V., Geroeva, Y.A., Shtepa, M.A., Ushakov, D. (2021), The crypto currency as money of digital economy. E3S Web of Conferences, 244, 10021.
- El-Berawi, A.S., Belal, M.A.F., Ellatif, M.M.A. (2021), Adaptive deep learning based cryptocurrency price fluctuation classification. International Journal of Advanced Computer Science and Applications, 12(12), 0121264.
- Equity against the Odds. (2018), Equity in and Through Education. p13-27.
- Ethereum. (n.d), Ethereum Energy Consumption. Available from: https://ethereum.org/en/energy-consumption
- Ftiti, Z., Louhichi, W., Ben Ameur, H. (2021), Cryptocurrency volatility forecasting: What can we learn from the first wave of the COVID-19 outbreak? Annals of Operations Research, 6, 1-26.
- Gallersdörfer, U., Klaaßen, L., Stoll, C. (2020), Energy consumption of cryptocurrencies beyond bitcoin. Joule, 4(9), 1843-1846.
- Giudici, G., Milne, A., Vinogradov, D. (2019), Cryptocurrencies: Market analysis and perspectives. Journal of Industrial and Business Economics, 47(1), 1-18.
- Guo, H., Zhang, D., Liu, S., Wang, L., Ding, Y. (2021), Bitcoin price forecasting: A perspective of underlying block-chain transactions. Decision Support Systems, 151, 113650.
- Guzmán, A., Pinto-Gutiérrez, C., Trujillo, M.A. (2021b), Trading cryptocurrencies as a pandemic pastime: COVID-19 lockdowns and bitcoin volume. Mathematics, 9(15), 1771.
- Hossain, M.A. (2021), What do we know about cryptocurrency? Past, present, future. China Finance Review International, 11(4), 552-572.
- House, W. (2022), Fact Sheet: Climate and Energy Implications of Crypto-Assets in the United States. The White House. Available from: https://www.whitehouse.gov/ostp/news-updates/2022/09/08/ fact-sheet-climate-and-energy-implications-of-crypto-assets-inthe-united-states/#:~:text=The%20United%20States%20is%20 estimated,mining%20is%20also%20highly%20mobile
- Hung, N.T. (2022), Asymmetric connectedness among S and P 500, crude oil, gold and Bitcoin. Managerial Finance, 48(4), 587-610.
- Huynh, T.L.D., Burggraf, T., Wang, M. (2020), Gold, platinum, and expected Bitcoin returns. Journal of Multinational Financial Management, 56(3), 100628.
- Inci, A.C., Lagasse, R. (2019), Cryptocurrencies: Applications and investment opportunities. Journal of Capital Markets Studies, 3(2), 98-112.
- IvanOnTech. (2022), Proof-of-Work Crypto Mining's Energy Consumption. Moralis Academy. Available from: https://academy. moralis.io/blog/exploring-proof-of-works-electricity-consumption
- Jareño, F., González, M.D.L.O., López, R., Ramos, A.R. (2021), Cryptocurrencies and oil price shocks: A NARDL analysis in the COVID-19 pandemic. Resources Policy, 74, 102281.
- Jin, X., Zhu, K., Yang, X., Wang, S. (2021), Estimating the reaction of Bitcoin prices to the uncertainty of fiat currency. Research in International Business and Finance, 58, 101451.
- Karim, B.A., Abdul Rahman, A., Mohd Amin, S.I., Khalid, N. (2021), Covid-19 and cryptocurrency markets integration. Studies in Systems, Decision and Control, 382, 75-85.
- Kaya, O., Mostowfi, M. (2021), Low-volatility strategies for highly liquid cryptocurrencies. Finance Research Letters, 46, 102422.
- Khalid Salman, M., Abdu Ibrahim, A. (2020), Price prediction of different cryptocurrencies using technical trade indicators and machine learning. IOP Conference Series: Materials Science and Engineering, 928, 032007.
- Khedr, A.M., Arif, I., Pravija Raj, P.V., El Bannany, M., Alhashmi,

S.M., Sreedharan, M. (2021), Cryptocurrency price prediction using traditional statistical and machine learning techniques: A survey. Intelligent Systems in Accounting, Finance and Management, 28(1), 3-34.

- Kiayias, A., Russell, A., David, B., Oliynykov, R. (2017), Ouroboros: A provably secure proof-of-stake blockchain protocol. In: Lecture Notes in Computer Science. Germany: Springer Science+Business Media, p357-388.
- Lahmiri, S., Bekiros, S. (2020), The impact of COVID-19 pandemic upon stability and sequential irregularity of equity and cryptocurrency markets. Chaos, Solitons and Fractals, 138, 109936.
- Lahmiri, S., Bekiros, S. (2021), The effect of COVID-19 on long memory in returns and volatility of cryptocurrency and stock markets. Chaos, Solitons and Fractals, 151, 111221.
- Li, J., Li, N., Peng, J., Cui, H., Wu, Z. (2019), Energy consumption of cryptocurrency mining: A study of electricity consumption in mining cryptocurrencies. Energy, 168, 160-168.
- Livieris, I.E., Kiriakidou, N., Stavroyiannis, S., Pintelas, P. (2021), An advanced CNN-LSTM model for cryptocurrency forecasting. Electronics, 10(3), 287.
- Livieris, I.E., Pintelas, E., Stavroyiannis, S., Pintelas, P. (2020), Ensemble deep learning models for forecasting cryptocurrency time-series. Algorithms, 13(5), 121.
- Livieris, I.E., Stavroyiannis, S., Pintelas, E., Kotsilieris, T., Pintelas, P. (2021), A dropout weight-constrained recurrent neural network model for forecasting the price of major cryptocurrencies and CCi30 index. Evolving Systems, 13(1), 85-100.
- Marobhe, M.I. (2022), Cryptocurrency as a safe haven for investment portfolios amid COVID-19 panic cases of Bitcoin, Ethereum and Litecoin. China Finance Review International, 12(1), 51-68.
- Mikołajewicz-Woźniak, A., Scheibe, A. (2015), Virtual currency schemesthe future of financial services. Foresight, 17(4), 365-377.
- Mnif, E., Jarboui, A. (2021), Resilience of Islamic cryptocurrency markets to Covid-19 shocks and the Federal Reserve policy. Asian Journal of Accounting Research, 7(1), 59-70.
- Mnif, E., Jarboui, A., Mouakhar, K. (2020), How the cryptocurrency market has performed during COVID 19? A multifractal analysis. Finance Research Letters, 36, 101647.
- Naeem, M.A., Bouri, E., Peng, Z., Shahzad, S.J.H., Vo, X.V. (2021), Asymmetric efficiency of cryptocurrencies during COVID19. Physica A: Statistical Mechanics and Its Applications, 565, 125562.
- Naeem, M.A., Qureshi, S., Rehman, M.U., Balli, F. (2021), COVID-19 and cryptocurrency market: Evidence from quantile connectedness. Applied Economics, 54(3), 280-306.
- Saad, S.M.S., Radzi, R.Z.R.M. (2020), Comparative review of the blockchain consensus algorithm between proof of stake (POS) and delegated proof of stake (DPOS). International Journal of Innovative Computing, 10(2), 27-32.
- Sarkodie, S.A., Ahmed, M.Y., Owusu, P.A. (2022), COVID-19 pandemic improves market signals of cryptocurrencies-evidence from Bitcoin, Bitcoin Cash, Ethereum, and Litecoin. Finance Research Letters, 44, 102049.
- Sarkodie, S.A., Owusu, P.A. (2022), Dataset on bitcoin carbon footprint and energy consumption. Data in Brief, 42, 108252.
- Schinckus, C. (2021), Proof-of-work based blockchain technology and anthropocene: An undermined situation? Renewable and Sustainable Energy Reviews, 152, 111682.
- Shao, Y.H., Xu, H., Liu, Y.L., Xu, H.C. (2021), Multifractal behavior of cryptocurrencies before and during COVID-19. Fractals, 29(6), 2150132.
- Shi, N. (2016), A new proof-of-work mechanism for bitcoin. Financial Innovation, 2(1), 1-8.
- Shuaib, K., Abdella, J.A., Sallabi, F., Serhani, M.A. (2022), Secure

decentralized electronic health records sharing system based on blockchains. Journal of King Saud University-Computer and Information Sciences, 34(8), 5045-5058.

- Smales, L.A. (2019), Bitcoin as a safe haven: Is it even worth considering? Finance Research Letters, 30, 385-393.
- Sohrabi, N., Tari, Z. (2020), ZyConChain: A scalable blockchain for general applications. IEEE Access, 8, 158893-158910.
- Squarepants, S. (2008), Bitcoin: A Peer-to-peer Electronic Cash System.
- Su, C.W., Xi, Y., Tao, R., Umar, M. (2022), Can bitcoin be a safe haven in fear sentiment? Technological and Economic Development of Economy, 28(2), 268-289.
- Susana, D., Kavisanmathi, J.K., Sreejith, S. (2020), Does Herding Behaviour among Traders Increase during Covid 19 Pandemic? Evidence from the Cryptocurrency Market. Re-Imagining Diffusion and Adoption of Information Technology and Systems: A Continuing Conversation, p178-189.
- Thazhungal Govindan Nair, S. (2021), Pairs trading in cryptocurrency market: A long-short story. Investment Management and Financial Innovations, 18(3), 127-141.

- Tschorsch, F., Scheuermann, B. (2016), Bitcoin and beyond: A technical survey on decentralized digital currencies. IEEE Communications Surveys and Tutorials, 18(3), 2084-2123.
- Valencia, F., Gómez-Espinosa, A., Valdés-Aguirre, B. (2019), Price movement prediction of cryptocurrencies using sentiment analysis and machine learning. Entropy, 21(6), 589.
- Valeonti, F., Bikakis, A., Terras, M., Speed, C., Hudson-Smith, A., Chalkias, K. (2021), Crypto collectibles, museum funding and OpenGLAM: Challenges, opportunities and the potential of nonfungible tokens (NFTs). Applied Sciences, 11(21), 9931.
- Yuan, X., Su, C., Peculea, A.D. (2022), Dynamic linkage of the bitcoin market and energy consumption: An analysis across time. Energy Strategy Reviews, 44, 100976.
- Yuneline, M.H. (2019), Analysis of cryptocurrency's characteristics in four perspectives. Journal of Asian Business and Economic Studies, 26(2), 206-219.
- Zhang, W., Li, Y., Xiong, X., Wang, P. (2021), Downside risk and the cross-section of cryptocurrency returns. Journal of Banking and Finance, 133, 106246.