Cryptocurrencies and Indian Stock market: An analysis of their relationship Pre & Post the Covid-19 Pandemic

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Abstract

This paper is an attempt to check the relationship between cryptocurrencies and the Indian stock market. S&P BDM index and NSE NIFTY 50 are used as a proxy to capture the movement of cryptocurrencies and Indian stock market respectively. The total time period of the study is also divided into two sub periods; pre-Covid and post-Covid period to check if there is any change in the relationship due to the occurrence of worldwide pandemic. The methodology involves the use of Unit Root test, Granger Causality test, VAR, Impulse Response analysis and Johansen Cointegration test to achieve the said objectives of the study.

It is found that there exists a short term causal relationship between NSE NIFTY stock market index and crypto currency S&P BDM index where Cryptocurrency returns do cause stock market returns but the reverse is not true. Further, there exists no long term relationship between the variables.

Keywords: Indian Stock Market, NSE Nifty-50, S&P BDM Index, Granger Causality Test, Johansen Cointegration Test.

Introduction:

The concept of cryptocurrency was discovered by pseudonym researcher Satashi Nakamoto in 2008. The first cryptocurrency which emerged was Bitcoin (BTC) based on the SHA-256 algorithm. It is considered as the "gold standard" of all the cryptocurrencies since it is the oldest and most reputable one. Another coin in the evolutionary chain of cryptocurrency was Litecoin (released in the year 2011), also known as the "silver standard" of cryptocurrency, gained modest success and

enjoyed the highest cryptocurrency market cap after Bitcoin till 2014. Some of the other cryptocurrencies evolved over time include Ethereum, Cardano, Dogecoin and so on. It is indubitable that the emergence of cryptocurrencies will play an indispensable role in the future economic progress. Today, the market of cryptocurrencies is known for its volatile prices and speculative returns.

Being one of the broadest financial assets, Stock market prices and returns are driven by multiple factors like the earning base & valuation of the company, macroeconomic conditions, market sentiments and impact of events or anomalies. These factors are correlated to the factors that affect the returns of other financial assets, suggesting that stock prices are correlated to prices of other financial assets. Understanding of this relationship is important for diversifying the portfolio risks and maximising the returns.

Out of many financial assets that influence the equity markets, cryptocurrencies are a fairly new addition. With an increasing number of investors making investment in both equities and cryptocurrencies to diversify their risks, it will be interesting to look at the relation between the two and check if returns of one are affected by the other. To check the possibility of a relationship between the two, this paper considers the NSE NIFTY 50 Index and S&P Broad Digital Market Index as a proxy to reflect the behaviour of the Indian stock market and cryptocurrency market.

Broadly, both the indices are defined as follows:

"The NIFTY 50 is a diversified 50 stock index accounting for 13 sectors of the economy. It is owned and managed by NSE Indices Limited (formerly known as India Index Services & Products Limited) (NSE Indices)."

"S&P Cryptocurrency Broad Digital Market Index provides a wide performance snapshot of the cryptocurrency market and it includes more than 240 coins."

To do a comprehensive analysis of the aforementioned relationship, apart from checking the above said relationship for the entire study period, the sub-periods have also been formed, namely, Pre-Covid and Post-Covid periods to analyse the impact of the Covid-19 pandemic on investor behaviour through their crypto buying behaviour.

In the present research paper, an attempt has been made to explore the relation especially the short run and long run causal relation between stock market returns and cryptocurrencies returns using daily data by means of descriptive statistics, correlation analysis and regression analysis and other econometric techniques like Unit Root Test, Vector AutoRegression, Granger Causality test, Impulse Response Analysis and Johansen Cointegration Test.

Further, the paper is arranged in the following sequence - in the second section, we present a brief literature review, the objectives of the

study are included in the third section. The fourth section contains the data sources used and methodology adopted. The fifth section talks about the empirical results derived out of the application of several techniques. And lastly, the sixth section summarises the research findings.

Literature Review:

Bhullar and Bhatnagar (2020) analyses the relationship between stock exchange movements and price movement of Bitcoin in India and China using VECM, Johnsen Co-integration and Granger Causality statistical techniques. The results show that there is no causal relationship between these two. It further talks about unidirectional causal effects between Indian Stock Exchange and Bitcoin depends upon the fiscal and monetary policies.

Demir, Bilgin, Karabulut and Doker (2020) analyse the relationship between cryptocurrencies and COVID-19 pandemic using ARDL and Wavelet analysis. It indicates that there was a negative relationship between Bitcoin value and Covid-19 cases, however, it becomes positive in the later period. It indicates that the hedging role of cryptocurrencies during uncertainty was raised by COVID-19.

Jeribi, Jena and Lahiani (2021) studied the behaviour of five cryptocurrencies and five developing markets (BRICS Market). It was clearly evident from the results that both the stock market returns as well as crypto returns are changing during the crisis period in a nonlinear and asymmetric framework. It suggested that speculators present in both markets may aim for a spread strategy to improve their portfolio returns.

K and D'souza (2020) examined the equilibrium of crypto currency with Indian stock market index returns, based on Bitcoin and NSE NIFTY. Their findings suggested a significant relationship among the Bitcoin currency with the Nifty Index. They observed a similarity of positive correlation between them during the months of April, September and November with a similarity of negative correlation during the months of February, March and June.

Lee, Guo and Wang (2017) analysed the behaviour of crypto currencies using the CRIX index. Their findings suggested that cryptocurrencies can be a good way to diversify the portfolio and reduce risks as it showed consistently low correlations with traditional assets, with a higher average daily return than most traditional asset classes. Since the research was done at an infant stage of crypto markets which has now evolved a lot, a fresh look at the correlation can be taken up.

Mendes and Carneiro (2020) analysed the cryptocurrency market based on 6 major crypto currencies between August 2015 and June 2020. Their findings suggested a high linear and non-linear correlation between the cryptocurrencies, especially during extremes. All the cryptocurrencies are positively correlated.

Sami and Arifuzzaman (2021) analysed and compared a pure stock portfolio with a mixed portfolio of stock and cryptocurrencies. The

findings suggested that even though profits are a bit higher in case of pure stock portfolios, in order to make the investment safer and more prediction oriented with less volatility expectation we should think about making investments in a mixed portfolio containing crypto currencies and stocks. The findings suggest a possible inverse relation and hedging opportunities between crypto currencies and stocks.

Thakar and Mand (2020) investigates the connection between BTC and Asian Stock Exchange. It was found that four markets (JPN, KOR, STI, HK) had the negative association and one market (PHIL) had a positive relationship with BTC in the long run, whereas, in the short run, KOR had a positive relationship with BTC movement. This reveals that BTC investment is suitable in the long run period rather than the short run period.

Umar, Rubbaniy, XU (2021) analysed the co-movement between five major crypto currencies and three major stock markets liquidities during the period from January 2020 to February 2021 showing short term liquidity of crypto currencies co-movement with NYSE index.

Ünvan (2019) analysed the impact of Bitcoin on USA, Japan, China and Turkey stock market indices, using Causality and Value at Risk (VaR) methods. The indexes used for the research were Nikkei225, SSE380, BIST100 and S&P 500. The findings suggested that bitcoin had a two way causality relation with BIST100, with a one way causality relation from SSE380 to Bitcoin and from Nikkei225 to Bitcoin.

Objectives of the paper

The objective of the present research study revolves around exploring the relationship between stock market and cryptocurrencies using Nifty and S&P BDM Index by applying a variety of statistical and advanced econometric techniques. It is also checked if there is any change in the relationship due to the occurrence of worldwide pandemic Covid19.

No previous study in the related subject matter had tried to analyse the relationship between overall stock market performance (Nifty) and broad market of cryptocurrencies (S&P - BDM Index) in Indian context. The previous research papers have focused only on examining the relationship between stock market and Bitcoin or a set of 2-3 cryptocurrencies and the present research work is carried out using the latest crypto market index. Our research work is one step ahead as we have taken the overall stock market performance and crypto market performance in both pre and post covid era. So, the impact of global pandemic on crypto movement has also been taken care of.

Also, we have used Impulse Response Analysis to find out the responsiveness of the stock market in relation to the crypto market movement in the economy and vice-versa with the help of graphs.

Data and Methodology

The data consist of daily time series observations of the values of S&P Cryptocurrency Broad Digital Market Index and values of NSE NIFTY from January 2018 to December 2021. The data for S&P BDM Index is taken from the official website of S&P. (www.spglobal.com) whereas for NSE NIFTY is taken from National Stock Exchange's official website (www.nseindia.com). The entire dataset is divided into two sub periods by taking January 30th as the date when first Covid19 case was found in India.

Sub-period I : 1st Jan, 2018 - 30 Jan, 2020 *(PRE-COVID PERIOD)*.

Sub-period II : 31st Jan, 2020 - 31 Dec, 2021 *(POST-COVID PERIOD).*

For the purpose of analysis and to derive the meaningful conclusions, the whole analysis is performed by taking the Logarithm of all the variables since the linear relationship among the variables is not being assumed in the log series. Also, Log NIFTY in its differenced form represents the return on Nifty and Log S&P BDM represents the return on S&P BDM.

Besides the usual descriptive statistics, the following statistical and advanced techniques are used.

Unit Root Test

Augmented Dickey Fuller (ADF) test and the Phillips and Perron (PP) test are tested to determine how much stationarity a time series model has. If the mean and variance of a speculative process are constant over time and the covariance between two time periods depend only on the distance between the time periods and not the actual time at which co-variance is calculated, then the process is said to be stationary. It is important to make sure that the time series is stationary because if the time series data is non-stationery, we can study its behaviour only for that time period which is taken under consideration rather than generalizing it over other time periods. Hence, for the purpose of prediction, non-stationary time series data holds very less practical value.

The equation which is used for testing ADF test for a series Xt has the following structure :

$$X_t = a + bt + tX_{t-1} + |dk\mathrm{T}X_{t-k} + e_t$$

1. b = 0 and |t|< 1, then series Xt is stationary.

2. b = 0 and t = 1, then the series is an $I(1)$ process.

3. b ≠ 0 and|t| < 1, then the series is trend stationary around a deterministic time trend.

e_t = pure white noise error term.

Phillips and Perron have found a more detailed theory of the unit root non-stationary series. The tests are quite similar to ADF tests, but they take into account an automatic correction to the DF process to allow for auto correlated residuals. They use non-parametric statistical methods to take care of the serial correlation in the error terms but without adding lagged difference terms. The tests give the same

conclusions in many cases but also suffer from the same limitations as the ADF tests faced.

Granger Causality Test

Granger causality test is used to check the short-term causal relationship between the Stock market and Crypto-market returns. It is a statistical hypothetical test which states that if past values of a variable X significantly contribute to predict the value of another variable Y, then X is said to Granger cause Y and vice versa (Granger 1969, 1988).

The test is based on the following two regression equations. Both of them are used to determine the direction of causality between the stock market values and cryptocurrency values.

$$X_t = a_1 + \sum_{k=1} b_{1k} X_{t-k} + \sum_{k=1} c_{1k} Y_{t-k} + e_{1t}$$

$$Y_t = a_2 + \sum_{k=1} b_{2k} Y_{t-k} + \sum_{k=1} c_{2k} X_{t-k} + e_{2t}$$

where Yt and Xt are the tested variables, $e1t$ and $e2t$ are mutually uncorrelated white noise errors, t is the time period, k denotes the number of lags and m denotes the maximum number of lagged observations in the model. The null hypothesis is $c1 = c2 = 0$ for all k's versus $c1 \neq c2 \neq 0$ for at least some k's. If the coefficients $c1$ are statistically significant while $c2$ are not, then Y granger causes X. However, if the reverse is true, then X granger causes Y. And, if both $c1$ and $c2$ are significant then there is a bi-directional causality. Finally, if both $c1$ and $c2$ are statistically zero, then X and Y are independent.

Johansen Cointegration Test

Cointegration analysis is applied to determine if there exists any long-run equilibrium relationship between several non-stationary time series data. Cointegration implies that the two cointegrated variables cannot wander-off for long without coming back to the mean distance ultimately. But it doesn't imply that the two series move synchronously on a daily basis.

Cointegration implies that a linear combination of 2 or more time series can be stationary, despite being non-stationery, individually. This analysis is also important for estimating error correction models (ECM). The term error correction is used to refer to the adjustment procedure between the short-run disequilibrium and desired long-run position.

"The Johansen method is based on the maximum likelihood procedure for determination of the presence of cointegrating vectors as a Vector Autoregressive (VAR) in a non-stationary time series.

Consider a VAR of order k:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \mathrm{g} + A_k Y_{t-k} + BX_t + f_t$$

where Y_t is a k-vector of non-stationary $I(1)$ variables, X_t is a vector of deterministic variables, k is the number of lags and f_t is a vector of innovations or error terms. We can

rewrite the VAR as:

$$\Delta Y_t = \pi Y_{t-1} + \sum_{i=1}^{k-1} \tau_i \Delta Y_{t-i} + BX_t + \varepsilon_t$$

$$\pi = \left(\sum_{i=1}^{k} Ai\right) - I$$

$$\tau_i = -\sum_{j=i+1}^{k} Aj$$

Here *Yt* is a vector of non-stationary variables. The information obtained through the coefficient matrix between the levels of the series Π is decomposed as Π = *ab*′ where the relevant elements of the *a* matrix are adjustment coefficients and the *b* matrix contains the co-integrating vectors. Johansen and Juselius (1990) specify two likelihood ratio test statistics to test for the number of co-integrating vectors. The first likelihood ratio statistics for the null of exactly *r* co-integrating vectors against the alternative of *r* + 1 vectors is the maximum eigenvalue statistic. The second statistic for the hypothesis of at most *r* co-integrating vectors against the alternative is the trace statistic. The number of lags applied in the co-integration tests is based on the information provided by the multivariate generalisation of the AIC.

Also, to determine the optimal lag length structure, AIC (Akaike Information Criterion) and SIC (Schwarz Information Criterion) criterions have been used." (Tripathi & Seth, 2014)

Impulse Response Analysis

Impulse Response Analysis is considered as an important step in econometric analyses which employs VAR (Vector Autoregressive Models). Its main purpose is to explain the evolution of the variables in a model in reaction to a shock in one or more variables with the help of graphs.

All the tests are applied on the total as well as the sub-periods.

TABLES

Table 1: Descriptive Statistics (Entire study period)

SERIES	NSE NIFTY	S&P BDM
MEAN	12344.74	1609.191
MEDIAN	11504.15	803.8950
MAXIMUM	18477.05	6215.990
MINIMUM	7610.250	268.7300
STANDARD DEVIATION	2368.694	1579.571
SKEWNESS	1.001714	1.350516
KURTOSIS	2.974823	3.340782
JARQUE-BERA	165.2579	305.1151
PROBABLITY	0.000000	0.000000

Source: Authors' Computation

Table 2: Karl-Pearson's Correlation Matrix

	Total Period	Sub-Period I	Sub-Period II
	S&P BDM	S&P BDM	S&P BDM
NSE NIFTY	0.90636336	-0.2934789	0.91333613

Source: Authors' Computation

Table 3: Results of Unit Root Tests on Level Variables (Log)

On Levels				
Variable	Constant and No Trend		Constant and Trend	
	ADF	PP	ADF	PP
LogNIFTY	-0.5356	-0.3245	-1.8457	-1.5641
LogS&PBDM	-0.2060	-0.2057	-2.2623	-2.2682

Source: Authors' Computation

Table 4: Results of Unit Root Tests on First Difference of Log Variables

On First Difference				
Variable	Constant and No Trend		Constant and Trend	
	ADF	PP	ADF	PP
LogNIFTY	-10.5845*	-33.3811*	-10.6203*	-33.4125*
LogS&PBDM	-31.4693*	-31.4695*	-31.6096*	-31.6114*

*(Significant at 5% level of significance)

Table 5: Estimates of Vector Auto-regression

VAR Estimates t-statistics in []	Total Period		Sub-Period I		Sub-Period II	
	NSE NIFTY	S&P BDM	NSE NIFTY	S&P BDM	NSE NIFTY	S&P BDM
NSE NIFTY (-1)	-0.07034	-0.08425	0.045305	0.306690	-0.12387	-0.22145
	[-2.1918]	[-0.6729]	[1.0161]	[1.1316]	[-2.6374]	[-1.5984]
NSE NIFTY (-2)	0.029238	0.12632	0.033603	-0.51156	0.023477	0.242524
	[0.9133]	[1.0115]	[0.7525]	[-1.8847]	[0.5041]	[1.7651]
S&P BDM (-1)	0.020802	0.000274	-0.000026	0.003081	0.050312	0.011006
	[2.5314]	[0.0085]	[-0.0358]	[0.0694]	[3.1901]	[0.2378]
S&P BDM (-2)	0.003672	0.039066	0.000280	-0.03252	0.011782	0.116228
	[0.4468]	[1.2183]	[0.0385]	[-0.7370]	[0.7402]	[2.4765]

Source: Authors' Computation

Table 6: Granger Causality Table- 2 lags (Log Differenced Series)

	DlogNIFTY		
	Total Period	Sub-Period I	Sub-Period II
DlogS&PBDM	▼	N	⧗

Source: Authors' Computation

Table 7: Results of Johansen's Co-integration Test

Hypothesis	Period	Null	Trace Test	Maximum Eigen Value	Co-integrating Relationship
No-co-integrating relationship between NIFTY and S&P BDM	Total Period	r=0 r≤1	0 0	0 0	No
	Sub-Period I	r=0 r≤1	0 0	0 0	No
	Sub-Period 11	r=0 r≤1	0 0	0 0	No

Source: Authors' Computation

Results

Descriptive Statistics

Table 1 shows the mean value to be 12344.74 for NSE NIFTY and 1609.191 for crypto index S&P BDM. From the skewness measure, we

found that both the variables are positively skewed to the right as their mean value is more than median and mode value. From Kurtosis values, it is found that the data is not normally distributed because kurtosis values are deviated from three. NSE NIFTY has kurtosis less than three, so it has platykurtic distribution while S&P BDM has kurtosis value greater than three implies that it has leptokurtic distribution.

Correlation Analysis

Table 2 suggests that there's a significantly high positive correlation between cryptocurrencies and stock markets for the total period. An interesting observation here is that before the outbreak of covid19, there was negative and insignificant correlation between the two variables while the relationship completely reversed post pandemic resulting in highly positive and significant relationship between the two indices.

The findings suggest that after the onset of the Covid-19 pandemic, the crypto and stock markets have become more closely related to each other.

Unit Root Test

The results of ADF and PP unit root tests on levels and at first differences for the entire period into consideration are presented in Table 3 and 4. It is found that the null hypothesis of time series has a unit root, could not be rejected for both stock market and cryptocurrency index at level series at 5% level of significance. Therefore, by taking the first order differencing for both the variables, the null hypothesis of non-stationarity was rejected at the same confidence level to lend continuity in the modelling process.

Regression Analysis

The findings of VAR, as presented in Table 5 suggest that in Sub-period I, there was no relation between the variables. However, the findings in Sub-period II are significantly different. In Sub-period II, cryptocurrencies have an influence on stock markets at Lag 1 at 5% level of significance while stock markets have an influence on crypto at 10% level of significance.

The findings of the total period are similar to the Sub-period II.

Granger Causality Test

Granger Causality test (Table 6) is employed on the first difference of log series of both the variables to check the short term causal relation between the variables.

The findings for the total period suggest that there is a one way causal relation from DlogS&PBDM to DlogNIFTY, that is, Cryptocurrency returns does granger cause stock market returns but the reverse is not true.

The results for Sub-Period I are significantly different as they suggest that there is no short term causal relation between the two variables.

For Sub-Period II, we find that there is a two

way causal relation between the variables, that is, for the post-covid period both cryptocurrency and stock market returns are granger causing each other.

This shift from no relationship to two-way causal relation is significant, suggesting that at least in the short run, crypto and stock markets have become more closely associated with each other post Covid-19 pandemic.

Johansen Co-integration Test

Johansen Co-integration Test is applied to check the long term causal relation between cryptocurrencies and stock markets. Given that our analysis involved two variables, we have used Bi-variate Johansen Co-integration test on the log series of variables.

The results of Johansen Co-integration Test (Table 7), suggest that there is no long term Causal relationship between the S&P BDM Index and NSE NIFTY for the total period.

Similar findings are visible for both the sub-periods as well.

Impulse Response Analysis

The result of Impulse response analysis matches with the results obtained from Granger Causality test. First set of graphs (Figure 1) for the entire period shows that Nifty responds positively and significantly to one standard deviation shock created in the cryptocurrency market that lasts for about 3 days. Similar results are found for the post-covid period (Figure 2). However, no significant relationship was found for pre-covid period (Figure 3).

FIGURE LEGENDS

Figure 1(A): Response of DLOGS&PBDM to DLOGNIFTY in *Combined Period*

Figure 1(B): Response of DLOGNIFTY to DLOGS&PBDM in *Combined Period*

Figure 2(A): Response of DLOGS&PBDM to DLOGNIFTY in *Pre-Covid Period*

Figure 2(B): Response of DLOGNIFTY to DLOGS&PBDM in *Pre-Covid Period*

Figure 3(A): Response of DLOGS&PBDM to DLOGNIFTY in *Post-Covid Period*

Figure 3(B): Response of DLOGNIFTY to DLOGS&PBDM in *Post-Covid Period*

FIGURES

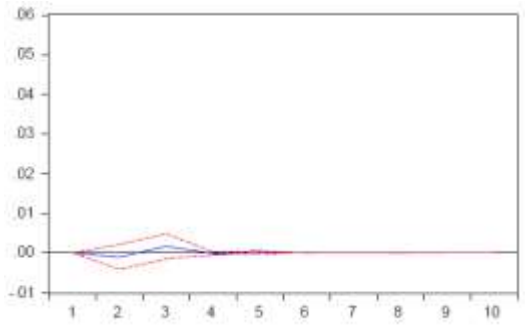

Figure 1(A): Response of DLOGS&PBDM to DLOGNIFTY in *Combined Period*

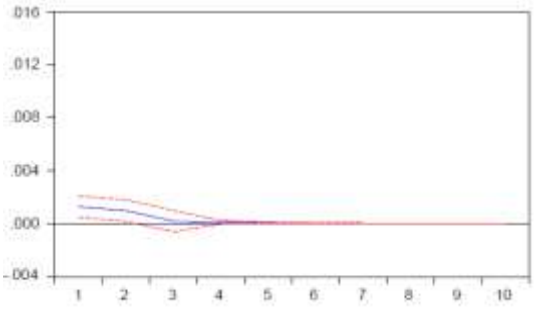

Figure 1(B): Response of DLOGNIFTY to DLOGS&PBDM in *Combined Period*

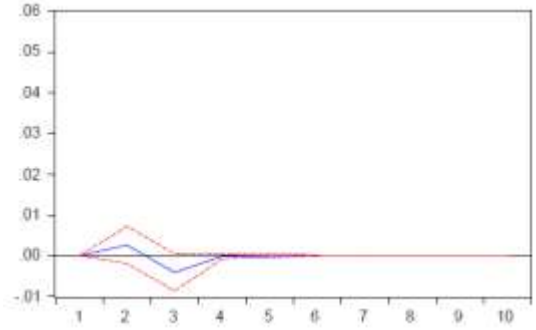

Figure 2(A): Response of DLOGS&PBDM to DLOGNIFTY in *Pre-Covid Period*

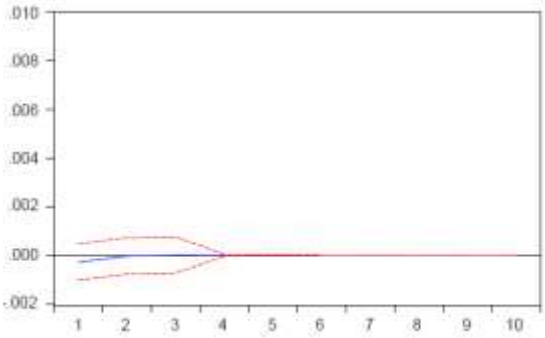

Figure 2(B): Response of DLOGNIFTY to DLOGS&PBDM in *Pre-Covid Period*

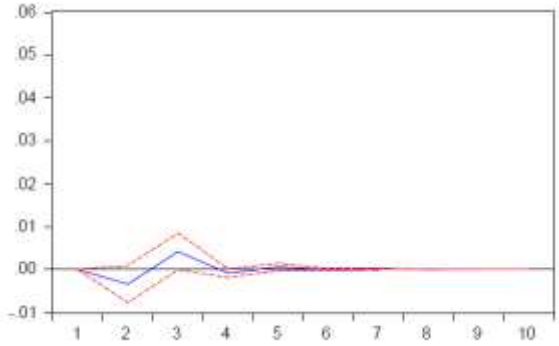

Figure 3(A): Response of DLOGS&PBDM to DLOGNIFTY in *Post-Covid Period*

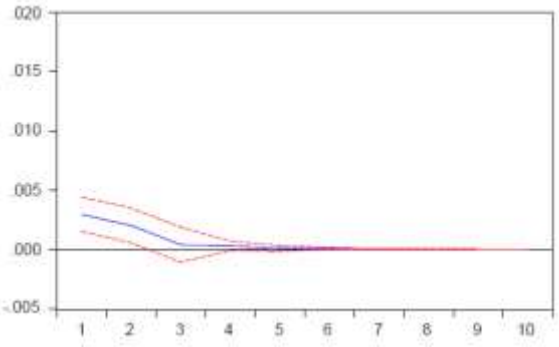

Figure 3(B): Response of DLOGNIFTY to DLOGS&PBDM in *Post-Covid Period*

Conclusion

The present research paper studied the causal relationship between cryptocurrency and stock market performance using NSE NIFTY-50 and S&P BDM Index for the period starting from January 2018 to December 2021 using Descriptive statistics, Correlation Analysis and some advanced econometric techniques such as Unit Root Test, Granger causality Test and Vector Autoregression to examine the short-run causal relation and Johansen Co-integration test to find out the long-term relationship between the variables. Impulse Response Analysis has also been performed to study the response of

stock market values to cryptocurrency values with the use of graphs. The daily index values of NSE NIFTY-50 are used as a measure for aggregate stock returns. The whole study period is divided into two sub-periods i.e. pre-covid and post-covid period and all the tests have been applied for the overall period as well as two sub-periods.

The findings are quite interesting. It is found that cryptocurrency returns granger causes stock market returns but stock market returns didn't cause movement in cryptocurrency market using Granger Causality Test. The findings of Granger Causality Test also varied during sub-periods. There was no short term causal relationship identified between stock market and cryptocurrency variables during Sub-period I but bi-directional causality was identified during sub-period II where stock market granger cause cryptocurrency returns and vice-versa, suggesting stock markets and cryptocurrencies have become more closely associated after the onset of the pandemic. Before application of Granger Causality Test, time series were tested for checking stationarity using ADF and PP unit root test.

The findings of the sub-period II are in sync with the recent crypto-market crash of May 2022, where both cryptocurrencies and stock market returns plummeted together suggesting that both the markets have indeed become more closely associated with each other after the Covid-19 pandemic.

The results of Johansen Cointegration reveal that there is no long term causal relationship between stock market and cryptocurrency variables for both sub periods and total period.

Policy Implications

Theoretical implications

The findings of the paper suggest that cryptocurrency is one of the major determinants of the stock market returns. Countries should encourage cryptocurrency transactions to develop new market mechanisms and innovations which will attract more investors in their financial system. Additionally, countries which are legalising cryptocurrency transactions in their financial system will in turn boost their investors' portfolio return and thereby, boost the country's economic growth.

Practical implications

This paper provides valuable insight for policymakers in India to examine the present situation of the cryptocurrency market and its impact on the performance of the Indian stock market as well as the economic growth of the country. Policymakers should evaluate various opportunities offered to investors in the cryptocurrency market and introduce them in the Indian stock market to boost the performance of the financial system and therefore, accelerate the economic growth of the country.

Further research and limitations

As this article is focused only on the

relationship between cryptocurrency market and Indian stock market, it is still insufficient to make a comprehensive statement regarding the behaviour of the two in other parts of the world. A possible extension of this paper is to analyse the relationship between cryptocurrency and stock market in different parts of the world such as Europe, Africa, and America. However, the results might vary over time if countries decided to implement new policies towards the cryptocurrency and Stock Market.

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