Relationship of Cryptocurrency Markets with the Stock Markets of India

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ARTICLE DETAILS	ABSTRACT
Research Paper	Investors may spread their money over a variety of market assets and reap the rewards of diversification. One such resource is cryptocurrency. But when it comes to developing economies, particularly India, the place of cryptocurrencies is still unclear. Thus, the purpose of this study is to investigate the connection between the cryptocurrency market and the Indian stock market. The closing prices of the Sensex, Bitcoin, and Ethereum were obtained from Bombay Stock Exchange (BSE) website and Investing.com. The results are obtained using econometric techniques including the Vector error correction model, Johansen cointegration, and the ADF test. The findings of the study indicate that there exists long-term cointegration among the markets. Moreover, Bitcoin and Ethereum impact the stock markets negatively and positively respectively.
Keywords : *Stock market, India, Cryptocurrency, bitcoin, Sensex, VECM*	

1. Introduction

Digital currency is a phenomenal innovation in the field of financial technology. There are various types of digital currency like cryptocurrency, stablecoins and central bank digital currency. All these currencies are traded or operated on blockchain technology. Bitcoin and Ethereum are the largest cryptocurrencies since their market is very high as compared to other such currencies. Currently, cryptocurrencies are traded like assets in various digital spaces. No country has allowed cryptocurrency as the legal tender of their country except El-Salvador since these currencies have high volatility and are not regulated by any kind of regulator therefore there are very high chances that allowing them as a legal

tender in any economy will pave the way for various economic problems such as inflation and money laundering because central banks will not be able to intervene in such kind of money market.

Even without being legal tender the cryptocurrency market have a high potential to influence the economy and other markets such as stock markets. Numerous research have been conducted to investigate the influence or function of cryptocurrencies on the economy's stock markets. One of the biggest stock markets in the world is the one in India. The BSE is the oldest stock exchange in Asia, with a market capitalisation of over USD 5 trillion. Since the number of investors in BSE is very high, it is highly needed to explore the impact of the cryptocurrency markets on the BSE market. Therefore, this paper aims to examine the relation of the top two cryptocurrencies with the Sensex i.e. the market index of the BSE.

The remainder of the paper is as follows: the literature review is presented in section 2. The Materials and Methodology are presented in Section 3, the Results are shown in Section 4, and the Study is concluded in Section 5.

2. Review of Literature

With an emphasis on volatility and performance, the study conducts a quantitative analysis of the link between cryptocurrencies and the U.S. stock market with the goal of improving financial decision-making insights (Yang, 2024). According to a study on blockchain dynamics, cryptocurrency, especially Bitcoin and Ethereum, has a strong link with stock market performance, suggesting its influence on conventional financial markets (Benarous et al., 2024). The study demonstrates asymmetric cross-correlations between the values of cryptocurrencies and global stock markets, emphasizing the need to make educated cross-market investments and gold's role as a buffer. (Mei-Jun & Guang-Xi, 2024). The BRICS financial markets and cryptocurrency are becoming more intertwined, particularly in times of uncertainty like COVID-19, although they have little bearing on the main US stock market (Wang & Wang, 2024). The study investigates the links that have changed over time between Bitcoin, gold, and the Dow Jones stock index, with the stock market having an impact on Bitcoin during the COVID-19 crisis (Toudas et al., 2024). The analysis shows a short-term, cyclical causal link between stock markets and cryptocurrencies, with stock market changes having little effect and gold prices having a major impact on cryptocurrency returns (Huang, 2024). Because cryptocurrencies enhance risk and volatility, they have an effect on the stock market. Given the increasing influence of the cryptocurrency market on traditional financial products, investors and policymakers should be aware of this relationship (Shi,

2023). Because equities and cryptocurrencies are treated similarly by investors, pricing patterns between both exhibit correlations. There is a link between the two markets since factors that affect stock prices also affect cryptocurrency values (Bunget & Georgiana-Iulia, 2023). The diverse roles that cryptocurrencies like Bitcoin, Ethereum, and Tether play in different stock markets as hedges, diversifiers, or safe havens illustrate the dynamic connectivity between the two markets (Sahu et al., 2024). The study investigates the link that is emerging between cryptocurrencies and stocks that mine them, as well as the effect that production parameters have on the volatility of cryptocurrency markets (Zhan & Zhang, 2024). The study examines how the stock market and cryptocurrency markets are mutually correlated, suggesting that there is a link between the two financial markets that may have an impact on one another's performance (Yakubu Ahmed et al., 2023). The volatility of cryptocurrencies has an adverse effect on the indices of the Egyptian stock market, offering some benefits for diversification and hedging, but the relationship varies depending on the index (Eldomiaty & Khaled, 2024). The study affirms that traditional financial markets, such as equities, and cryptocurrencies have a dynamic interaction. It is possible to use cryptocurrencies as a strategy for portfolio diversification (Prabhune et al., 2023). There is no correlation between emerging stock market indexes and cryptocurrencies, despite the fact that cryptocurrency values are quite persistent. On the basis of volatility, conditional volatility analysis shows some mean reversion and cointegration (Ahmed et al., 2022). Cryptocurrency and stock markets displayed strong conditional relationships during the COVID-19 pandemic, suggesting financial contagion. The ability to act as a safe haven and a hedge against equities markets was lost by cryptocurrencies (Niyitegeka & Zhou, 2023).

Objectives of the study

1. To investigate the cointegration of the cryptocurrency and Indian stock markets.
2. To investigate the connection between the cryptocurrency market and the Indian stock market.

3. Materials and Methods

The closing prices of the Sensex were retrieved from the BSE database and the data for the cryptocurrency (Bitcoin and Ethereum) was extracted from the investing.com website. Investing.com website is widely used in the finance literature which is why we relied on this website. The paper has employed econometrics methodologies such as the Augmented Dickeyfuller Test (ADF), Vector Error Correction Model (VECM) and Johanson Cointegration Test.

Test of stationarity:

Verifying the stationarity of the data is the initial step in any time series analysis process since the results of the non-stationary data cannot be generalized. To find out whether the data is stationary or not, the Augmented Dickey-Fuller (ADF) test is used to test the unit root. The ADF test involves estimating the following regressions (with constant and with constant and trend term) for both the level and first difference of the price series in order to determine if the nonstationary series is a difference stationary or has a trend factor in it.

Following is the ADF test equation:

$$\Delta P_t = \beta_1 + \delta P_{t-1} + \alpha_i \sum_{i=1}^{t} \Delta P_{t-i} + \varepsilon_t$$

(1)

$$\Delta P_t = \beta_1 + \beta_2 t + \delta P_{t-1} + \alpha_i \sum_{i=1}^{t} \Delta P_{t-i} + \varepsilon_t$$

(2)

Cointegration test:
If series are found to be non-stationary at level, then it is advisable to check the cointegration among the series therefore we employed the Johanson cointegration test to examine if the cointegration exists among the series. If cointegration exists then, it is to be said that series are cointegrated at level. And their results will be valid (a non-stationarity feature of such series would not affect the reliability of the results). Following is the equation of the cointegration:

$$\Delta P_t = \alpha + \Pi P_{t-1} + \sum_{i=1}^{J-1} \Gamma_i \Delta P_{t-i} + \varepsilon_t$$

(3)

Vector Error Correction Model (VECM):
VECM is another form of Vector autoregression model (VAR), VECM is applied when the the series are non-stationary but cointegrated at level, therefore, the we chose VECM model rather than VAR model. Following is the equation for the VECM model:

$$\Delta X_t = \mu + \Phi D_t + \Pi X_{t-p} + \Gamma_{p-1} \Delta X_{t-p+1} \dots + \Gamma_1 \Delta X_{t-1} + \varepsilon_t, \quad t = 1, \dots, T$$

(4)

4. Results

ADF Test

The results of the ADF test presented in table 1, 2 and 3 state that the series is not stationarity at the level for all the datasets because the P value is 0.9802 (for Sensex), 0.7638 (for Bitcoin) and 0.5992

(Ethereum) which is greater than five per cent which means that we cannot reject the null hypothesis and the statement of the null hypothesis is that all series are not stationary or the series has a unit root. Therefore, we took the first difference of the series and then applied the ADF test again, now the P values turned out to be 0.000 for all the series which indicates the rejection of the null hypothesis. Table 1 concludes that the data in the level form is non-stationary data, hence we now need to check whether the data is co-integrated or not thereafter we will move to the regression part.

Table 1 ADF test of Sensex

		(at level)	(at first difference)	P value (at level)	P value (at first difference)
ADF t- test statistic		0.336782	-18.50085	0.9802	0.0000
Critical values:	1%	-3.433355	-3.433355		
	5%	-2.862754	-2.862754		
	10%	-2.567462	-2.567462		

Table 2 ADF test of Bitcoin

		(at level)	(at first difference)	P value (at level)	P value (at first difference)
ADF t-test statistic		-0.975528	-8.925028	0.7638	0.0000
Critical values:	1%	-3.433374	-3.433374		
	5%	-2.862762	-2.862762		
	10%	-2.567467	-2.567467		

Table 3 ADF test of Ethereum

		(at level)	(at first difference)	P value (at level)	P value (at first difference)
ADF t-test statistic		-1.368370	-15.16877	0.5992	0.000
Critical values:	1%	-3.433377	-3.433360		
	5%	-2.862764	-2.862756		
	10%	-2.567468	-2.567464		

Cointegration results

Table 4. Trace value

Cointegration Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	P value
None *	0.017778	56.22953	35.01090	0.0001
At most 1 *	0.007784	19.54558	18.39771	0.0345
At most 2	0.001741	3.564195	3.841465	0.0590

Trace test confirms 2 cointegrating equations at the 5% level

* Indicates that null hypothesis is rejected at the 5% level

Table 5.

Cointegration Test (Maximum Eigenvalue)

Hypothesized Number of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	P value
None *	0.017778	36.68395	24.25202	0.0007
At most 1	0.007784	15.98139	17.14769	0.0733
At most 2	0.001741	3.564195	3.841465	0.0590

Max-eigenvalue test confirms 1 cointegrating equation at the 5% level

* Indicates that null hypothesis is rejected at the 5% level

Under the Johanson cointegration test there are two measures that are used to check whether the cointegration exists or not; one is Trace statistic and another is Max-Eigen statistic. The results of both these statistics are presented in Table 4 and Table 5 respectively. The null hypothesis is that there is no cointegration. However, the P value of both the statistics comes out to be significant. The trace statistic (Table 4) states that at the 5% significance level, at most two cointegration equations are present however Max-Eigen statisitc (Table 5) states that at most one cointegrating equation is there. Both the statistics reject the null hypothesis at the five per cent significance level, hence it can be concluded that all series are cointegrated. It means that the VECM model is to be applied to examine the relation rather than the VAR model.

VECM results

Table 6. VECM

Vector Error Correction Estimates
Period: 3/14/2016 6/18/2024
Number of observations: 2046
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Equation:	CointEq1
SENSEX(-1)	1.000000
BITCOIN(-1)	3.533959 (0.73392) [4.81516]
ETHEREUM(-1)	-67.64699 (11.5939) [-5.83469]
C	-39209.68

Error Correction:	D(SENSEX)	D(BITCOIN)	D(ETHEREUM)
CointEq1	1.26E-05 (0.00040) [0.03162]	0.004805 (0.00097) [4.93618]	0.000404 (7.3E-05) [5.55370]
D(SENSEX(-1))	-0.046122 (0.02206) [-2.09062]	-0.024969 (0.05399) [-0.46245]	-0.005184 (0.00403) [-1.28492]
D(BITCOIN(-1))	-0.010409	-0.017633	0.000585

	(0.01367)	(0.03347)	(0.00250)
	[-0.76119]	[-0.52690]	[0.23395]
D(ETHEREUM(-1))	0.786499	-0.942354	-0.102553
	(0.18199)	(0.44539)	(0.03328)
	[4.32176]	[-2.11581]	[-3.08167]
C	25.88090	34.25359	1.959696
	(10.1604)	(24.8664)	(1.85797)
	[2.54723]	[1.37751]	[1.05475]

Table 6. presents the long-run relationship among the Sensex, bitcoin and Ethereum. The Upper panel of the table shows the coefficients of the cointegrating equation that denotes the long-run relationship. The lower panel signals the short-term relationship. In the long run the the signs of the coefficient are interpreted as opposite, such that a negative coefficient will be considered as positive and a positive coefficient will be considered as negative. The coefficient of lagged bitcoin is 3.53395 and the coefficient for the lagged Ethereum is -67.64699. This coefficient means that the relation between Bitcoin and Sensex is negative in the long run and the relation between Sensex and Ethereum is positive in the long run. However, the relation between Sensex and bitcoin is not because the t-statistic value is -0.76 lie between -1.96 and 1.96. The relation between Sensex and Ethereum is significant at a five per cent level because the t-statistic value is 4.321 which is greater than 1.96, and we can say that the null hypothesis of no significance can be rejected. In the lower panel, the error correction term is 1.26E-05 however it is not significant, this term denotes the speed of the adjustment in the long run. Here is signals that the series adjusts positively towards the equilibrium in the long run. However the speed of adjustment is not significant.

Table 7. Estimates of Equation

Dependent Variable: D(Sensex)
Period: 3/14/2016 6/18/2024
D(SENSEX) = C(1)*(SENSEX(-1) + 3.5339585157*BITCOIN(-1) -
    67.6469855146*ETHEREUM(-1) - 39209.677367) + C(2)
    *D(SENSEX(-1)) + C(3)*D(BITCOIN(-1)) + C(4)*D(ETHEREUM(
    -1)) + C(5)

	Coefficient	Standard Error	t-Statistic	P value
C(1)	1.26E-05	0.000398	0.031615	0.9748
C(2)	-0.046122	0.022061	-2.090621	0.0367
C(3)	-0.010409	0.013674	-0.761185	0.4466
C(4)	0.786499	0.181986	4.321762	0.0000
C(5)	25.88090	10.16041	2.547230	0.0109

R-squared	0.016938	Mean dependent var		25.70046
Adjusted R-squared	0.015011	S.D. dependent var		462.2151
S.E. of regression	458.7328	Akaike info criterion		15.09725
F-statistic	8.791403	Durbin-Watson stat		2.004779
Prob(F-statistic)	0.000000			

Table 7 shows the short-term link between the two markets. For both short-term and long-term relations, we estimate the equation. The long-run coefficient is represented by coefficient C(1), while the short-run coefficient is represented by the remainder. The short-run relation between Sensex and its lag is negative signals by the coefficient C(2) -0.046122. The relationship between the Sensex and Bitcoin is also negative, which means that in the short run if the price of bitcoin rises then the market price of the Sensex will fall by -.0.010409. However, the positive relation between Ethereum and Sensex signals that in the short run, the rising Ethereum will also raise the Sensex.

Table 8

Breusch-Godfrey Auto Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	2.510752	Prob. F(2,2042)	0.0815
Obs*R-squared	5.021451	Prob. Chi-Square(2)	0.0812

We estimate the equation in the table 7. To test the validity of the coefficient estimated, we need to run the diagnostic test, therefore we run the autocorrelation or serial correlation test (LM test) to examine whether there exists serial correlation in the residuals of the estimated equation, if the autocorrelation

found to be present then it is considered that model is not estimated properly otherwise model is fit. Table 8 presents test statistics and P values of the LM test; the P value is 0.0815 which is more than 0.05. This shows that there is no serial correlation in the residual, hence the mode is fit or estimated properly.

5. Conclusion

Cryptocurrencies are a new-age financial asset. A significant amount of funds is being invested daily in cryptocurrency markets, however, their relation with stock markets was loosely explored especially in India. Therefore, this study took the objective to explore the relationship between major cryptocurrencies and Sensex which is considered as the barometer of the Indian economy. The last five years (starting from 2019) data was retrieved from the official website of the BSE and Investing.com. Econometric tools such as the ADF test, Johanson Cointegration test, and Vector Error Correction Mode were employed to fetch the relationship among Sensex, bitcoin and Ethereum.

The findings of this manuscript are as follows: first, this study advocates the long-run cointegration among the Sensex, bitcoin and Ethereum. Second, there is a negative impact of the bitcoin and a positive impact of the Ethereum on the Sensex in the long run. With the help of short-run adjustment, the market comes the equilibrium in the long run however this adjustment speed is not significant.

The limitation of this paper is that many other significant cryptocurrencies are left in the dataset, that can be taken as a sample by the future researcher to reproduce and validate the findings of this study. Moreover, the study is silent on the causation therefore, future researchers and use the multiple causality test to examine the variables that are causing the movement of another variable.

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