Relationship between Macro Variables and Bitcoin: Evidence From Indian Market

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This paper investigates the long-haul relationship between Bitcoin (INR) and the macroeconomic indicators such as Indian stock indices (NSE and BSE), exchange rate (USD and INR) and proxies of inflation rate (CPI and WPI) in the Indian market. For this, monthly data of the variables from October 2014 to September 2019 is considered. The result of Johansen cointegration approach emphasizes the long run association between Bitcoin and the economic variables. On the other hand the Granger Causality test demonstrates one-way causal relationship of NSE, BSE and CPI to the Bitcoin. Hence, concluded that Bitcoin prediction relies on stock Indices and inflation.

Keywords: Bitcoin, Macroeconomic Variables, Johansen Co integration, Granger Causality

1. Introduction

Identifying causes of change in any asset is one of the important questions in finance. In recent decade, the role of macroeconomic variables has been critically noted and researched by academicians and practitioner of financial economics. It is found that changes in macroeconomic variables or monetary indicators of an economy are one of the important reasons for the variation in prices of conventional assets such as equity, commodities, derivatives etc. Vast literature is available demonstrating that macroeconomic variables have impact on conventional markets such as stock market in varied time horizons across the globe (Chaudari, 1997; Kwon & Shin, 1999; Maysami, Howe & Hamsa, 2004; Ahmed et al., 2017).

Cryptocurrency is the new topic of research and discussion for academics, practitioners and investors around the globe since 2008, after it was first proposed by Satoshi Nakamoto in his white paper. Though it is a nascent market, it has spread across the world like a wild fire. Bitcoin market is alone expected to exceed the market cap than that of India's most valuable listed company (Varma, 2019). Thus, it becomes a topic of importance to understand if Bitcoin, the original crypto currency also gets affected by the economic indicators of a country alike the conventional investing assets such as stock, equity etc. This is of importance to investors, researchers and policy makers, to understand that Bitcoin also follows the basic economic criterions like any other traded investment assets.

Thus, the present study focuses on investigating the long-haul relationship between Bitcoin (INR) and the macroeconomic indicators such as Indian stock indices (NSE and BSE), exchange rate (USD and INR) and proxies of inflation rate (CPI and WPI) in the Indian market. For this purpose, monthly observations of Bitcoin and macro indicators with reference to Indian market are extracted from varied reliable sources for a period starting from October 2014 to September 2019. The econometric techniques of Augmented Dickey-Fuller, Johansen cointegration analysis and Granger causality are employed to examine the relationship and its causation direction between the variables. This will provide empirical evidence from Indian market about the long-run association of Bitcoin to the macro variables of India.

The present paper is structured as follows: Section 2 deals with the review of relevant literature related to the study; Section 3 briefs about the research framework used; Section 4 discusses empirical results, its analysis and interpretation; Section 5 offers the concluding remarks.

2. Review of Literature

Over the years, researchers have taken important monetary macroeconomic variables and employed varied econometric techniques to prove its relationship to developed, developing and emerging markets. Vast literature is available analyzing impact and relationship of varied macroeconomic variables such as Interest rate, inflation rate, GDP, exchange rate etc on major stock markets across the world (Ahmed, 2017; Maysami, Howe and Hamsa, 2004; Kwon & Shin, 1999; Chaudari, 1997).

Crypto currency being a relatively new market which is at its infancy stage, the empirical literatures studying this nascent market is now growing. The relationships between varied international currencies exchange rates, traditional asset class (crude-oil, gold), popular stock indexes, commodity index, and Bitcoins have been analyzed (Corelli, 2018; Trabelsi, 2018; Bianchi, 2018; Eken & Baloglu, 2018). Various factors affecting the price movement of Bitcoins like news and social media sentiments (Kim et al., 2016; Lamon, Nielsen & Redondo, 2017) movement in gold price, crude oil price, movement in major stock indices (Kristoufek, 2015; Das & Kannadhasan, 2018), and varied internal and external factors such as demand and supply, interest rate (Sovbetov, 2018) have been studied. It is also found that Bitcoin are interdependent and co-integrated with each other (Ji et al., 2018; Chu et al., 2017).

The studies reported are majorly focusing on effect of variables such as gold price, crude oil price, movement in major stock indices or varied internal and external factors on prices and returns of Bitcoin or its association with other crypto currencies. This paper intends to focus on Indian market and examine long-run association and causation of major macroeconomic variable of India (Indian stock indices, foreign exchange rate and inflation rate) with Bitcoin (INR), the twinkling new investing asset of in the market.

3.   Research Framework

This study examines the long-run association between the original crypto currency Bitcoin and macroeconomic variables of Indian stock indices (NSE & BSE), foreign exchange rate (USD and INR) and inflation rate (CPI and WPI). Month-to-month data from October 2014 to September 2019 is used for the study. The study is carried out by collecting monthly closing price of Bitcoin (in INR) and monthly prices of macroeconomic variables with reference to Indian economy. Similar studies have been carried out in stock market in varied time horizons across the globe (Ahmed et. al, 2017; Chaudari, 2008; Kwan & Shin, 1999).

3.1 Variables of the study

This study employs five macroeconomic indicators, stock indices of NSE and BSE, exchange rate of US dollar in Indian Rupees and CPI and WPI (two proxies of inflation rate). The monthly closing price of Bitcoin (INR) is used as dependent variable. While the above mentioned five macroeconomic variables are taken as independent variables.

3.2 Sample Period and sources

As mentioned above, study uses monthly data of Bitcoin, NSE, BSE, foreign exchange rate, CPI and WPI. The data is synchronized in a manner that each variable have 60 observations from October 2014 to September 2019. Table 3.1 gives a brief description of the macroeconomic variables, its data frequency and source.

Table 3.1 *Brief of the Variables*

Variables	Variable Description	Frequency	Source
Dependent Variable			
BTC	Bitcoin(INR)	Monthly	Yahoo Finance India
Independent Variables			
BSE SENSEX	Bombay Stock Exchange Index	Monthly	Yahoo Finance India
NSE Nifty	National Stock Exchange Index	Monthly	Yahoo Finance India
EXR	Exchange Rate (INR/$)	Monthly	fredst.louisfed.org
CPI	Consumer Price Index	Monthly	CMEI Economic Outlook
WPI	Wholesale Price Index	Monthly	CMEI Economic Outlook

Source: Author's Compilation

3.3 Estimation Techniques

This research intends to examine the long-haul relationship between Bitcoin (in INR) and macroeconomic indicators (NSE, BSE, Exchange rate, CPI & WPI), providing evidence from the Indian market. Thus the study employs Johansen cointegration approach to ratify the relationship between Bitcoin and macroeconomic indicators. Moreover, descriptive analysis and granger causality is also applied to analyse economic indicators causality and its direction to Bitcoin.

1. Unit Root test (Augmented Dickey-Fuller): To run any econometric techniques on the time – series data, the researcher has to look for presence of unit root in the series, i.e. if series is stationery or not. If unit root is found in the series, it indicates that series is non-stationary. In such case, the series has to be transformed into a stationary one. (Dickey and Fuller; 1979)
2. The Johansen Cointegration: If data series of two variables are in linear stationary combination, they are said to be cointegrated to each other and have a long-run association. This analysis has two steps: first, it should be determined that the data series is stationary at first difference level, and subsequently test of cointegration can be applied.
3. Granger Causality Test: This test investigates causal relations between the variables. If the data series of variables are found cointegrated, it will have a causal ordering atleast in one direction. (Engle & Granger, 1987).

4.   Empirical Results, Analysis & Interpretation

The study employed descriptive analysis, Johansen's cointegration analysis and Granger causality to scrutinize the long-haul association of Bitcoin, the original crypto currency with the macroeconomic indicators, giving an evidence of the same from the Indian economy.

4.1 Descriptive Analysis

Table 4.1 gives average (mean), volatility (standard deviation), minimum and maximum values and normality (skewness) of the variable series used in the study. The monthly average closing price of Bitcoin in India was Rs. 2,24,153.04 with

maximum price being Rs. 9,03,603.06 and minimum price of Rs. 13,484.96 during the period of the study. The monthly average price of NSE and BSE were Rs. 9,509.12 and Rs. 31,252.87 respectively. The average monthly exchange rate of US dollar in India was Rs 66.57. The average inflation index of Consumer price and wholesale price were 132.25 and 114.53. The value of skewness shows that data series of all variables are symmetrical except for CPI, which is negatively skewed.

Table 4.1 *Descriptive Statistics*

Statistics	BTC	NSE	BSE	USDEX	CPI	WPI
Mean	242153.04	9509.12	31252.87	66.57	132.25	114.53
Std. Dev	257128.78	1353.05	4615.81	2.90	7.48	4.39
Minimum	13484.96	6987.05	23002.00	61.37	119.40	107.10
Maximum	903603.06	11922.80	39714.20	73.56	145.80	122.00
Skewness	0.82	0.19	0.32	0.32	-0.13	0.31
Kurtosis	-0.67	-1.32	-1.24	-0.52	-1.05	-1.21

Source: Author's Calculations

4.2 Unit Root Test (Augmented Dickey-Fuller)

The result of ADF test has been depicted in Table 4.2. The null hypothesis of this test is that unit root exists in the data series. The result shows that unit root existed in data series of all the variables of the study at level. Therefore, data were transformed and examined at first difference order, where series became free of unit root problem and became stationary. Consequently, at first difference order, the data series have been integrated and made stationary, suitable for further econometric analysis to be employed.

Table 4.2 *Unit Root Test (Augmented Dickey-Fuller)*

Variables	ADF Unit Root	
	Level	First Difference
BTC	-1.11	-7.17*
BSE	-0.46	-7.95*
NSE	-0.71	-6.96*
EXR	-1.32	-6.29*
CPI	-1.03	-4.53*
WPI	-0.26	-5.43*

* Significance at 1% level; Critical Values: -3.54 at 1%, -2.91 at 5% and -2.59 at 10% level

Source: Author's Calculations

4.3 Lag Length Selection

Before employing the Johansen's multivariate cointegration analysis, it is mandatory to work out and find an optimum lag length from the series. There are varied criterions on the basis of which an optimum lag length for the series can be singled out such as Akaike information criterion; Schwarz Information criterion, Hannan-Quinn criterion, Log-Likelihood criterion etc. This research study selected the optimum lag length on the basis of Akaike (1969) Information Criterion i.e. AIC. The AIC suggests two lags for the time series data as the least value of AIC (58.66) corresponds to two lags for the selected sample period. Table 4.3 shows the values of varied criterions at different lags and the selected optimum lag length corresponding to the least value of the AIC.

Table 4.3 *Optimum Lag Length – AIC*

LAG	LOGL	LR	FPE	AIC	SC	HQ
0	-1897.283	NA	4.60e+22	69.21029	69.42927	69.29497
1	-1571.877	567.9814	1.25e+18*	58.68643	60.21930*	59.27921*
2	-1535.336	55.80737*	1.28e+18	**58.66678***	61.51354	59.76764
3	-1515.350	26.16370	2.59e+18	59.24910	63.40975	60.85806
4	-1476.749	42.11000	3.04e+18	59.15452	64.62907	61.27157
5	-1437.996	33.82086	4.37e+18	59.05441	65.84285	61.67955

* indicates lag order selected by the criterion; test statistics

Source: Author's calculation

4.4 Johansen Multivariate cointegration Analysis

As the unit root test of ADF in Table 4.2 demonstrates that Bitcoin and the macroeconomic variables in the study are cointegrated at first difference order, we can thus employ the Johansen Cointegration approach to the data series to examine long-haul association of the Bitcoin with the macroeconomic indicators. Results depicted in Table 4.4 and Table 4.5 clearly shows that there is one cointegrating equation present, thus, establishing a long-run association of Bitcoin (in INR) and stock indices (NSE & BSE), foreign exchange rate, CPI and WPI of India. Both Trace statistics and Max-eigen value are greater than the critical value and also statistically significant, $p < 0.05$.

Table 4.4 *Johansen Test Result (Trace test)-unrestricted Co integration rank Test*

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value at 0.05 level	Probability**
None *	0.506	109.15	95.75	0.004
At most 1	0.399	68.84	69.81	0.059
At most 2	0.325	39.79	47.85	0.229
At most 3	0.154	17.35	29.79	0.614
At most 4	0.126	7.78	15.49	0.488
At most 5	0.000	0.04	3.84	0.823

Source: Author's calculation

Trace test indicates 1 cointegrating equation(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 4.5 *Johansen Maximum Eigen Value Test - unrestricted Co integration rank Test (maximum eigen-values)*

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	Critical Value at 0.05 level	Probability**
None *	0.506	40.30	40.07	0.047
At most 1	0.399	29.05	33.87	0.169
At most 2	0.325	22.44	27.58	0.198
At most 3	0.154	9.56	21.13	0.784
At most 4	0.126	7.73	14.26	0.405
At most 5	0.000	0.04	3.84	0.823

Source: Author's calculation

Max-eigenvalue indicates 1 cointegrating equation(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

4.5 Granger Causality Test

It is clear from the Johansen cointegration approach, that Bitcoin and macroeconomic variables are having long-run association in India. It is also necessary to identify the direction of this causal association among the variables, applying granger causality test (Engle & Granger, 1969). Thus, table 4.6 depicts the result of granger causality test. It can be seen that Bitcoin have a one way causal association with NSE, BSE and CPI. Other variables do not have any causation in either direction.

Table 4.6 *Result of Granger Causality Test*

	Pairs	Df	F-Test	p-value	Conclusion
Bitcoin (lag 2)					
1.	BTC does not granger cause NSE	2	0.14	0.86	*Unidirectional Relation*
	NSE does not granger cause BTC	2	4.11	0.02**	
2.	BTC does not granger cause BSE	2	0.33	0.72	*Unidirectional Relation*
	BSE does not granger cause BTC	2	3.42	0.03**	
3.	BTC does not granger cause EXR	2	2.76	0.07	*No Relationship Exists*
	EXR does not granger cause BTC	2	0.69	0.50	
4.	BTC does not granger cause CPI	2	0.00	0.99	*Unidirectional Relation*
	CPI does not granger cause BTC	2	3.94	0.02**	
5.	BTC does not granger cause WPI	2	1.37	0.26	*No Relationship Exists*
	WPI does not granger cause BTC	2	2.44	0.09	

** indicates rejection of null hypothesis at 5% significance level

Source: Author's Calculation

5. Conclusion

Many previous studies have empirically proved that macro indicators of an economy have an impact on the conventional markets of stock, commodity and foreign exchange markets, both domestically and globally. This research initiated with a purpose to scrutinise the long-haul relationship of macroeconomic variables on the nascent market of crypto currency i.e. Bitcoin, providing evidence from the Indian Market. For this, monthly data of Bitcoin (in INR) and macro indicators i.e.

Indian stock indices (NSE and BSE), foreign exchange rate (US dollar and Indian Rupee) and Inflation rate (CPI and WPI) were considered from October 2014 to September 2019. Descriptive analysis, ADF test, Johansen co-integration approach and Granger causality were employed. Johansen multivariate cointegration analysis ratified long-haul association of Bitcoin with macroeconomic indicators in the Indian market. Further analysis of granger causality demonstrated one-way causal relationship of NSE, BSE and CPI to the Bitcoin. Hence, the evidence from Indian market concludes that Bitcoin prediction relies on stock Indices (NSE-Nifty, BSE - SENSEX) and Consumer Price Index of Inflation.

6. References

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