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Revisiting the Weak Form of Efficiency of Indian Stock Market during Covid 19 Pandemic[1]

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Abstract:
Efficiency of stock market depends upon how quickly market assimilates new information. This paper attempts to investigate the validity of the Efficient Market Hypothesis (EMH) and Random Walk Hypothesis (RWH) in the Indian Stock Market during Covid 19. Discussing existing literature in brief and taking National Stock Exchange (NSE)'s index Nifty to represent Indian stock market, the study applies the Autocorrelation Function and Partial Autocorrelation Function, Lung-Box Q-statistic, Unit Root test and Variance Ratio Test in order to establish evidence of the weak-form of efficiency of the Stock Market. The results do not support existence of weak-form of efficiency and random walk for stock market returns in India. This advocates that the Indian stock markets are weak form inefficient during Covid 19 pandemic signifying that stock prices are predictable and provide opportunities to earn abnormal returns.

Keywords: *Efficient Market Hypothesis (EMH), National Stock Exchange (NSE), Autocorrelation, Unit root, Random walk*

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I. Introduction

The global financial market stability came under stress with the outbreak of coronavirus. The prices of equities collapsed and stock market volatility increased. Many emerging market economies witnessed the harshest reversal of portfolio flows due to fear among investors. On March 11, 2020, the World Health Organization (WHO) declared coronavirus disease as COVID 19 and declared it a pandemic after the virus had infected 114 countries throughout the world. In repercussion to this news, the Sensex fell by 2919.26 points (-8.18 percent) on March 12, 2020, and the Nifty-50 dropped by 868.25 points (-8.30 percent). On March 23, 2020, the Sensex plunged 13.5 percent and the Nifty plunged 12.98 percent as the pandemic situation worsened and the number of patients in India increased. However. India's stock market has made a stunning comeback since June 1, 2020 amidst Covid 19 pandemic. With the arrival of this new crisis like situation, it became interesting to know whether stock prices follow random walk and stock markets become weak-form efficient after the outbreak of Covid 19 and during its continuation.

Efficient Market Hypothesis is a critical area of research for stock price movement. The efficient market hypothesis states that stock prices should reflect all available information and as a result, prices should always be consistent with 'fundamentals. Efficient stock markets provide the vehicle for mobilizing savings and investment resources for economic developmental. They afford opportunities to investors to diversify their portfolios across a variety of assets. A stock market is considered ideal if prices provide accurate signals for resource allocation so that firms can make productive investment decision and investors can choose among the securities under the assumption that securities prices at any time fully reflect all available information. A market in which prices fully reflect all available information is called efficient.

Three levels of efficiency of market were identified by Fama (1965): the strong form, the semi-strong form and the weak-form of efficiency. Market is said to have strong form of efficiency, when the current price reflects all information i.e., public, private as well as information contained in past prices and no investors will be able to identify under-valued stocks. Market is considered to have semi-strong form of efficiency, when the current price reflects the information contained past prices as well as public information and there is no

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mechanism that can predict stock prices by using this information. Market is weak-form of efficient, when the current price reflects the information contained in all past prices only, suggesting no technical analyses be useful in predicting prices and finding under-valued stocks. Market efficiency influences the investment strategy decision of an investor. Lower the market efficiency; the greater will be the predictability of stock price changes. New information comes in a random fashion in an efficient market, so stock price movements should be random to this new information arrival. In a weak-form efficient market, price movements occur arbitrarily and successive price changes are discrete of one another. The Random Walk Hypothesis of stock market prices first developed by Bachelier (1900) states that price changes cannot be predicted. The successive price change between two periods is independent with zero mean and variance depends upon interval between two periods.

In the light of above background, the purpose of this study is to investigate whether stock prices in India follow a random walk as required by the weak-form of market efficiency after the outbreak of Covid 19 and its continuing presence. Thus, the hypothesis for this study is as follows.

"India stock market follows random walk i.e.; the Indian Stock Market is efficient in weak form."

II. Literature Review

Since Fama (1965) propounded his famous efficient market hypothesis for US securities, a number of empirical research have been carried out to test its validity in the developed and emerging countries with booming financial markets (Summers, 1986; Fama and French, 1988; Lo and Mackinlay, 1988). Fama (1991) categorised the market efficiency studies into three categories. The first category involves the tests of return predictability accepting random walk hypothesis; the second group contains event studies and the third tests for private information. The early studies on testing the weak form efficiency on the developed stock markets, generally agree with the support of weak-efficiency of the market considering a low degree of serial correlation (Fama, 1965 and 1970). However, Porterba and Summers (1988) confirmed the presence of mean reverting tendency and absence of random walk in the U.S. Stocks. Lo and McKinney (1988) proposed variance ratio test to test random walk hypothesis. Their findings provided the evidence against random walk hypothesis for the entire sample period of 1962 to 1985. Fama and French (1988) discovered that forty percentage of variation of longer holding period returns were predictable from the information on past returns for U.S. Stock markets. Kim, Nelson and Startz (1991) observed the random walk pattern of stock prices in five Pacific-Basin Stock Markets and found that all stock markets except Japanese stock market did not follow random walk. Culter, Porterba and Summer (1990) found evidence of the mean reversion and predictability of the US stock market return. Walsh (1997) employed variance ratio test to test the null hypothesis of random walk in the Australian Stock Exchange and the results suggested that many indices of the stock exchange returned to random walk during October Crash 1987.

Madhusudan (1998) found that BSE sensitivity index of 30 stocks and BSE national index of 100 stocks did not follow random walk. Using correlation analysis on monthly stock returns data over the period January 1981 to December 1992, Olowe (1999) showed that the Nigerian stock market is weak form efficient. Pant and.Bishnoy (2001) observed the behaviour of the daily and weekly returns of five Indian stock market indices for random walk and found that Indian Stock Market Indices did not follow random walk. Ma and Barnes (2001) tested both Shanghai and Shenzhen stock market for efficient market hypothesis using serial correlation, runs and variance ratio test to index and individual share data for daily, weekly and monthly frequencies and found that Chinese stock markets were not weak form efficient. Osei (2002) investigated the asset pricing characteristics and response to annual earnings announcement of the Ghana Stock market. He concluded that Ghana Stock Market is not efficient with respect to annual earnings information releases to the Ghanian Market. Chakraborty (2006) investigated the stock price behaviour using daily closing price of Milanka Price Index and daily closing prices of twenty-five underlying individual companies included in the index. The study found that stock market in Sri Lanka did not follow random walk, while results of weak form efficient market hypothesis in twenty-five companies showed mixed outcome. Simon and Laryea (2006) studied the weak form of efficient market hypothesis for four African stock markets-Ghana, Mauritius, Egypt and South Africa. Their results reported that South African market was weak form efficient, whereas that of Ghana, Mauritius and Egypt were weak form inefficient.

Mishra and Pradhan (2009) investigated the efficiency of Indian stock market in the context of global financial crisis, 2008 by employing the unit root tests on daily stock returns. The results rejected the presence of weak form market efficiency in India. They also examined the mean reversion implication of market inefficiency and advocated the existence of mean reversion deception in India. Joshi (2012) carried out a study to check the efficiency level in Indian Stock market and its random walk nature by employing RUN test for six major indices (BSE 30,BSE 100,200,500, BSE SMALL CAP and BSE MIDCAP).The findings revealed absence of market efficiency in Indian Stock Market in long run but supported market efficiency in short term. Phan and Zhou (2014) conducted a study to examine the random walk hypothesis in case of the Vietnamese stock market using autocorrelation test, variance ratio test, and runs test for selected stocks and the Vietnam

stock index (VN-Index) and rejected the hypothesis that stock prices follow the random walk. Said and Harper (2015) checked weak-form efficiency for the Russian stock market by applying autocorrelation, the Box-Ljung test statistics and the variance ratio test and suggested that the stock prices in Russia do not reflect all the information from past stock prices and thus market is not weak-form efficient. Ali et al. (2018) investigated the comparative efficiency of twelve Islamic and conventional stock markets counterparts by adopting multifractal de-trended fluctuation analysis (MF-DFA) and reported that Islamic stock markets are comparatively more efficient than their conventional counterparts. Dias et al. (2020) examined weak-form market efficiency for the stock market indices of Belgium, France, Germany, USA, Greece, Spain, Ireland, Portugal and China by adopting panel unit root tests and variance ratio variance ratio. They observed mixed results about presence of the efficient market hypothesis.

Thus, the existing literature reveals conflicting evidence on weak-form market efficiency for different markets mainly due to different methodology employed, different data sets for different periods. This provides a motivation to revisit the question "Whether Indian Stock follow random walk during Covid 19 pandemic?".

III. Objective

The objective of current study is to contribute to the existing empirical literature relating to testing of Efficient Market Hypothesis during Covid 19 pandemic by employing Autocorrelation Function and Partial Autocorrelation Function using Lung-Box Q-statistic, Augmented Dickey Fuller Unit Root test, Phillip Perron Unit Root test and Variance Ratio Test to examine weak form of market efficiency. By using recent data after outbreak of Covid 19, the study would be able to capture the recent trends having impact on the efficiency of stock market in India. The findings of this study will be useful to investors as it will increase their understanding of the pricing process prevailing in the stock market.

IV. Data And Methodology

The present study employs the daily closing price data of CNX Nifty for a period starting from March 11, 2020 to June 9, 2021, the period after the World Health Organization declared Covid 19 as pandemic which drastically triggered stock market sentiments. The data is taken from official website of NSE (www.nseindia.com). This study has employed auto-correlation function and partial auto-correlation function using Ljung Box Q-Statistic, unit root test using Augmented Dickey Fuller (ADF) test statistic and Phillip Perron test statistic and Variance Ratio test to examine weak form of market efficiency.

The daily closing price data of the Nifty is transformed into return series which is computed as the first difference of the natural logarithm of closing prices. Return can be calculated as follows.

Symbolically,

$$\mathbf{R_t = \ln (P_t / P_{t-1})} \qquad \mathbf{(1)}$$

R_t = the log return for day t.
P_t = Closing Price at the end of t
P_{t-1} = Closing Price at the end of day t-1
t = Day
ln= Natural log

An important guide to the properties of a time series is provided by a series of quantities called auto correlation functions (ACFs) and partial autocorrelation functions (PACFs), which measure the correlation between observations at different distances apart. A correlogram displays the ACFs and PACFs of a time series up to the specified number of lags. The Ljung–Box test is a type of statistical test of whether any of a group of autocorrelations of a time series are different from zero. Instead of testing randomness at each distinct lag, it tests the "overall" randomness based on a number of lags, and is therefore a portmanteau test. The last two columns reported in the correlogram[2] are the Lying Box Q- statistics and their p-values (Ljung and Box,1978). The Q-statistic is often used as a test of whether the series is white noise. If Q exceeds the tabulated critical value associated with the chosen signification level, the null hypothesis of uncorrelated returns is rejected.

To test the stationary properties of a time-series, unit root test for stationarity is performed. To check stationarity of Nifty return series, the present study employs Augmented Dickey Fuller Test (1979) and Phillip-Peron Test (1988).

The predictability of stock prices i.e., random walk could be checked with Variance Ratio Test initiated by Lo and MacKinlay (1988). This test examines the predictability of stock price data by comparing variances of differences of the returns calculated over different intervals. If returns follow a random walk, the variance of

[2] See Table 2

a n-period difference should be n times the variance of the one-period difference. This study adopts Variance ratio test for testing the null hypothesis that the Nifty return series follows random walk.

V. Empirical Findings

The empirical analysis begins with visual depiction of Nifty returns for the period March 11, 2020 to June 9, 2021 consisting of 332 observations as shown in Figure1. Figure.1 indicates appearance of distinct periods of stability and volatility.

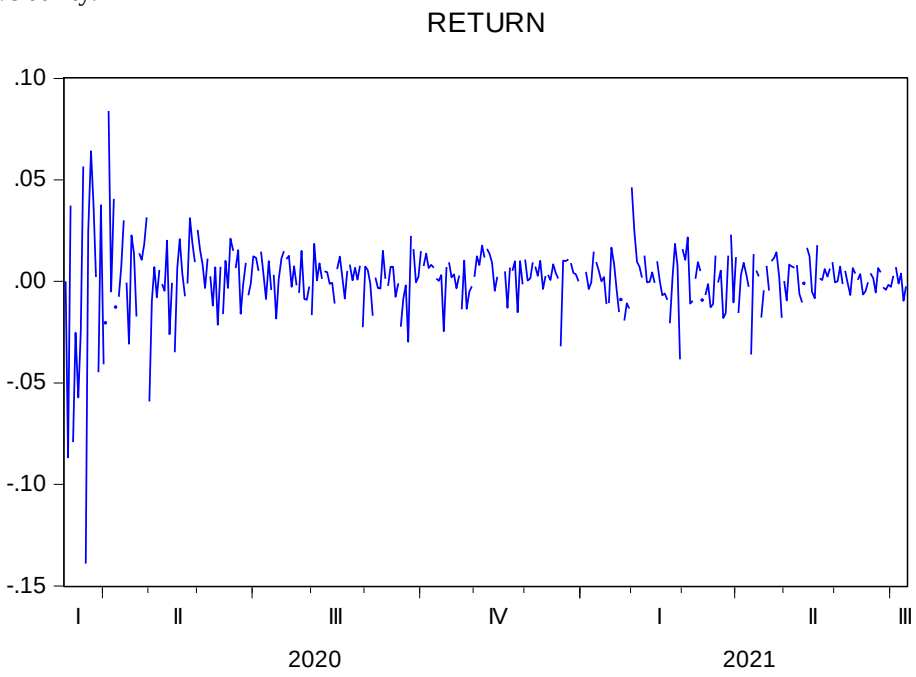
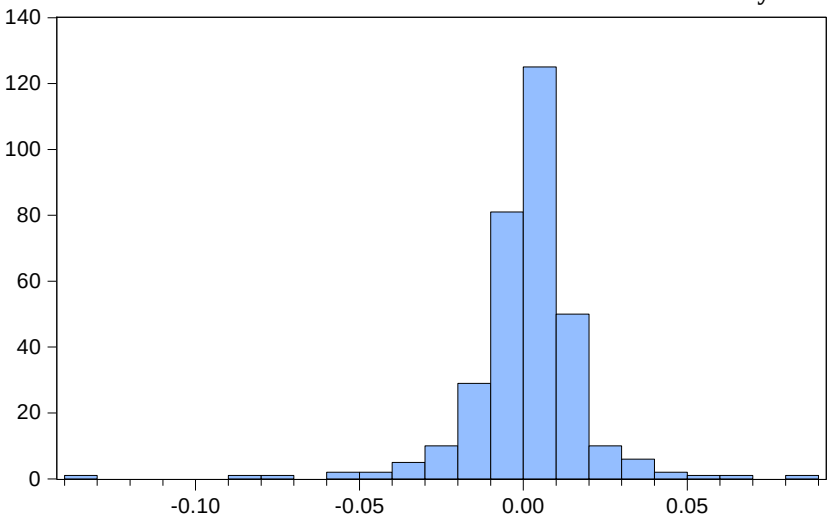


Figure 1: CNX Nifty Returns Graph

Data characteristics of Nifty returns along with histogram of returns are summarized in Table 1. Table 1 shows that mean return is close to zero, however standard deviation is quite large compared to mean but muss less than 1. The return series is negatively skewed and the kurtosis of the return series is large, meaning it is leptokurtic. Thus, Nifty returns follow all typical characteristics of financial asset returns. The Jarque-Bera statistic rejects the null hypothesis of normal distribution of the return. Thus, Nifty returns are not normally distributed.

Table 1 : Data characteristics of Nifty Returns



Series: RETURN	
Sample 3/11/2020 7/09/2021	
Observations 328	
Mean	0.001167
Median	0.002335
Maximum	0.084003
Minimum	-0.139038
Std. Dev.	0.018121
Skewness	-1.786923
Kurtosis	17.78283
Jarque-Bera	3161.162
Probability	0.000000

The calculated values of ACFs, PACFs and Ljung-Box Q-statistics upto 36 lags are given in Table 2. The results for the estimates of ACFs and PACFs depict the return series is not random as there is evidence strong autocorrelation at lag 1 along with certain other lags of higher order, being outside the asymptotic bound

(1.99/√T=0.1092). The significant value for Q (1) statistic at 5 percent level establishes that there is autocorrelation return series. This suggests that prices do not follow a random walk as these are not independent. The current price is dependent on past prices and is predictable.

Table 2: Results of ACFs, PACFs and Ljung-Box Q Statistics for Nifty Return

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
*|. |	*|. |	1	-0.135	-0.135	6.0742	0.014
.|. |	.|. |	2	0.011	-0.008	6.1111	0.047
.|. |	.|. |	3	0.051	0.052	6.9804	0.073
.|. |	.|. |	4	-0.028	-0.014	7.2442	0.124
.|* |	.|* |	5	0.187	0.185	18.983	0.002
**|. |	**|. |	6	-0.267	-0.232	42.866	0.000
.|* |	.|* |	7	0.155	0.113	50.987	0.000
.|. |	.|. |	8	0.012	0.016	51.038	0.000
*|. |	*|. |	9	-0.119	-0.094	55.847	0.000
.|. |	.|. |	10	0.046	-0.019	56.574	0.000
*|. |	*|. |	11	-0.157	-0.085	65.020	0.000
.|* |	.|. |	12	0.114	0.007	69.458	0.000
.|. |	.|. |	13	-0.011	0.060	69.499	0.000
*|. |	.|. |	14	-0.082	-0.053	71.845	0.000
.|. |	.|. |	15	0.030	-0.043	72.157	0.000
*|. |	*|. |	16	-0.125	-0.072	77.547	0.000
.|* |	.|. |	17	0.090	0.014	80.361	0.000
.|. |	.|. |	18	-0.049	-0.004	81.203	0.000
.|. |	.|. |	19	-0.042	-0.022	81.835	0.000
.|. |	.|. |	20	0.033	-0.037	82.226	0.000
.|. |	.|* |	21	0.043	0.109	82.880	0.000
.|. |	.|. |	22	-0.005	-0.057	82.891	0.000
.|. |	.|. |	23	-0.028	0.024	83.161	0.000
.|. |	*|. |	24	-0.064	-0.100	84.639	0.000
.|* |	.|. |	25	0.111	0.071	89.047	0.000
.|. |	.|. |	26	-0.046	-0.043	89.806	0.000
.|. |	.|. |	27	-0.010	0.026	89.845	0.000
.|. |	.|. |	28	0.057	0.023	91.005	0.000
.|. |	.|. |	29	-0.052	-0.025	91.984	0.000
.|. |	.|. |	30	0.037	-0.033	92.470	0.000
.|. |	.|. |	31	-0.064	0.005	93.953	0.000
.|. |	.|. |	32	0.003	-0.039	93.956	0.000
.|. |	.|. |	33	0.042	0.016	94.614	0.000
.|. |	.|. |	34	-0.030	0.012	94.941	0.000
.|* |	.|* |	35	0.115	0.095	99.792	0.000
.|. |	.|. |	36	0.005	0.064	99.801	0.000

The results of the unit root test are presented in Table.3 and Table.4. The results of ADF test given in Table 3 indicate that ADF test statistic is lower than its critical value at all the levels of significance (with p-value =0.0000). Thus, the ADF test rejects the null hypothesis of unit root in the returns series. This too suggests that Nifty returns do not show characteristics of random walk and the stock market in India is not efficient in the weak form.

Table 3: Results of Augmented Dickey Fuller (ADF) Test of Unit Root

Null Hypothesis: RETURN has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=16)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-20.59829	0.0000

Test critical values:	1% level	-3.450285
	5% level	-2.870219
	10% level	-2.571464

*MacKinnon (1996) one-sided p-values.

The results of Phillip Perron test given in Table 4 also show that adjusted t-statistic is lower than its critical value at all (1 percent, 5 percent and 10 percent) levels of significance and therefore, the PP test also rejects the hypothesis of unit root in the Nifty returns which means that return series is stationary and stock prices are not independent.

Table 4 : Results of Philip Perron (PP) Test of Unit Root

Null Hypothesis: RETURN has a unit root
Exogenous: Constant
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-20.49489	0.0000
Test critical values:	1% level	-3.450285	
	5% level	-2.870219	
	10% level	-2.571464	

*MacKinnon (1996) one-sided p-values.

The results of variance ratio test given in Table 5 depict two set of results. First the "Joint Tests" z-statistics is significant at 1 percent and strongly rejects the null of random walk of Nifty returns. The individual variance ratio z-statistics for period 2, 4, 8 and 16 generally reject the null hypothesis of random walk of Nifty returns though period 16 individual variance ratio z-statistics is having p-value greater than 0.05 but less than 0,10 that is significant at 10 percent level.

Table 5: Results of Variance Ratio Test

Null Hypothesis: RETURN is a martingale				
Joint Tests		Value	df	Probability
Max |z| (at period 2)*		3.191155	325	0.0057
Individual Tests				
Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	0.424335	0.180394	-3.191155	0.0014
4	0.215153	0.292720	-2.681225	0.0073
8	0.100842	0.401517	-2.239404	0.0251
16	0.052888	0.563177	-1.681730	0.0926

VI. Conclusion

Though the dynamics of stock market during pandemic may look random and insane to a layman but closer look at stock price movements in the current pandemic revealed that stock market in India did not react blindly to ongoing pandemic and stock prices are predictable providing opportunities to traders and investors to earn supernormal profits. The results of all the tests employed: ACF, PACF, Ljung-Box Q-statistic, ADF test, PP test, Variance Ratio test: confirmed the absence of weak-form of market efficiency and random walk of stock prices during Covid 19 pandemic. This establishes that the information regarding yesterday's and today's stock prices can be used to predict tomorrow's stock prices. The stocks prices do not reflect all past information effectively. It means investors can identify available undervalued stocks in the market and earn abnormal returns.

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