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Testing the Efficiency of the Indian Stock Market during COVID-19

Kushboo Luniya[a], Mugdha Basarkar[b]*

[a, b] *Student, B.Sc. in Economics and Finance, University of London, London*

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*Corresponding Author:
mugdhabasarkar@gmail.com

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ABSTRACT

Purpose: *The aim of this paper is to assess the market efficiency of Indian Stock Markets during the COVID 19 Pandemic. More specifically it tests for the validity of Weak Form Efficiency. Market efficiency is fairly important for various market players as it is an indicator on which they base their investment decision.*
Design/methodology/approach: *Daily data of 10 indices has been gathered for a period of 15 months from March, 2020 to May, 2021. A variety of tests namely the Runs test, Autocorrelation Functions, Correlograms and Box Pierce test have been used to evaluate efficiency levels.*
Findings: *This paper concludes that the Indian Stock Markets are not weak form efficient for the period under consideration, indicating that stock prices do not reflect all possible information and are mispriced. This allows for the use of technical analysis, trading rules and Fundamental analysis to generate abnormal returns.*
Research Limitations/Implications: *The current study is based on particular time frame.*
Originality/Value: *This research is original in contribution to existing literature.*

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Introduction

Assessing the efficiency of Stock Markets is crucial as they are fundamental in both the economic growth and development of an economy. Stock Markets play a major role in channelizing funds from investors to companies with profitable projects which in turn lead to economic development. India being an emerging economy makes the stock markets even more crucial and lucrative due to the large volume of FDI that flows into our markets from the world over. In this paper we aim to evaluate the level of market efficiency of Indian Financial Markets during the ongoing Coronavirus Pandemic.

The global Coronavirus pandemic hit India around January, 2020. The first ever nationwide lockdown was announced on 24th March and both the Benchmark Indices SENSEX & NIFTY50 recorded all-time lows for the period under consideration. The Indian Economy has faced 2 massive waves of Coronavirus, having caused inevitable damage and has rendered many unemployed. This has definitely influenced the stock markets and has surely impacted the efficiency levels of the same during these stressful times.

The Benchmark Indices of the Indian stock markets i.e. SENSEX AND NIFTY 50 have been booming over the last 15 months despite the tremendously fluctuating coronavirus situation and GDP growth of the economy. Both the above-mentioned Indices have reached all time high records during the ongoing COVID 19 Pandemic.

We have chosen 5 Indices in both Bombay Stock Exchange (BSE) and National Stock Exchange (NSE). We have focused on the Benchmark Indices as they are a fair representation of the Indian stock markets, apart from that we have picked the Healthcare and IT Index as these sectors have gained a lot of importance owing to the outbreak of the global pandemic. We have also considered 2 other sectors, namely the Banking and the Real estate sector. The banking index was primarily chosen as this Industry plays a critical role in channelizing funds which leads to higher Investment and consumption in an economy. The motivation for choosing the Real estate index was again its huge share in the Indian GDP and the amount of employment opportunities that it provides. Due to the Pandemic and Lockdown, many workers were laid off, relocated and benched. In spite of the lockdown, the Index continues to show an upward trend.

Quite a few studies on Indian stock market efficiency have been done and we have seen mixed results with regard to market efficiency at different time horizons, but none have gone ahead to test the markets during the COVID 19 pandemic. Few of these studies have been examined in detail in the literature review section. Hence the aim of this study is to help one ascertain Indian stock market efficiency using various Indices during these stressful times. In this paper we test weak form efficiency using Autocorrelation functions (to check for serial autocorrelation) and Runs test (to test if the indexes follow random walk). Difference of this study with previous research papers is the usage of various indices and the time period under consideration.

Informationally efficient markets imply that stock prices reflect all available information (past, present and private), ruling out the possibility of unexploited arbitrage and excess returns. In an efficient market price are accurate signals helping investors channelise funds in the most optimal investments which in turn leads to economic development. The level of market efficiency acts as an indicator for both institutional and retail investors guiding them to make decisions. Fama (1970) defines various levels of market efficiency based on the Information set being considered. Following are the 3 levels of market efficiency (Fama, 1970).

Weak form Efficiency

As defined by Fama (1970), Weak Form Efficiency implies that prices reflect all past information and hence this rules out the use of past price investment strategies, volume data usage or technical analysis to earn a superior return. This is the lowest level of market efficiency and is a necessary condition to be satisfied in order to achieve higher levels of efficiency.

Semi Strong form Efficiency

Semi Strong Form Efficiency implies that prices correctly, swiftly and quickly incorporate all publicly available information and announcements. Public information includes (but is not limited to) Annual Reports; Mergers, Acquisitions, Dividend announcements, and major Macroeconomic events. If we consider a market to be Semi strong form efficient then fundamental analysis is ineffective.

Strong form Efficiency

Strong form efficiency is the highest level of Information efficiency of the market, and this suggests that all past, public and private

information has been incorporated into the prices. In Strong form efficient markets, all prices are correctly and fairly priced and there does not exist a free lunch. Also, the above 3 levels of Market efficiency are mutually inclusive, i.e., for markets to be Strong form efficient, as a prerequisite they need to be both Semi strong and Weak form efficient.

Review of Literature

Patel et al.(2018)**:** In this study, the data of BSE Sensex has been taken from 1st April, 2015 to 31st March, 2018 to test the weak form of market efficiency. The study uses Run Test to check for randomness in behaviour of stock over the 3-year period. The test statistic being negative shows a positive serial correlation and as the p value is 0.00, the test concluded that the null hypothesis is rejected and there was no dependence of the market on the past trends. Therefore, the markets are not weak form efficient and investors can earn abnormal profits by analysing trends in the short run. This study only analyses BSE Sensex which can be a limitation as this leaves out so many other stocks. The paper studies only a 3-year period which is a small sample size. Also, the study does not try to analyse NSE in spite of it being a major Indian Stock Exchange. These few reasons really make the paper very narrow and do not give a broader understanding of the Indian Stock Markets.

Andrianto & Mirza (2016)**:** This paper examines Weak Form Efficiency in the Indonesian stock market by testing 3 Indices for the tenor of 2013-14, using the Runs Test. The findings imply that the Indonesian markets are Weak Form Efficiency, with only 6 stocks out of 86 stocks listed on the index violating the null hypothesis of randomness. It was also found that there was no serial autocorrelation persistent in both 2013 and 2014 again indicating weak form efficient markets. Only a meagre amount of evidence (4.4% to 8.8%) against weak form efficiency was found in the Indonesian Stock Markets. It was also found that markets were more efficient in 2014 than 2013 and the same is possibly due to larger market participation, technological upgrades and easy access to information over time. One major limitation of this study was the time series data which was considered for 2 years only.

Devansh Jain et al. (2020) **:** This paper aims to test Weak form efficiency of SENSEX and NIFTY from March, 2010 to March, 2019. The research Methodology used is Runs Test, Autocorrelation and Correlograms. The study concluded that markets are not Weak Form Efficiency and hence Investors could use Technical and Fundamental analysis to outperform the markets. It was found that both the major indicator indices did not follow random walk and also exhibited strong serial correlation. One major drawback of the paper was the limited usage of stock indices, as SENSEX consists of only 30 stocks and NIFTY consists of 50 such stocks.

Sachin K & Sanningammanavara (2014) **:** This study examines the Weak Form efficiency of NSE by analyzing the price movements of 23 nifty stocks in different sectors such as Automobile, Energy, Finance, FMCG and Pharma. The study uses data for 10 years starting from 1st April, 2004 to 31st March, 2014. The study uses Runs Test and Autocorrelation to analyse the data. The Runs Test is performed separately on each of the different sectors. In each case, the null hypothesis is rejected which suggests that the prices do not follow random walk. In the Autocorrelation tables, the values seem to be very high which suggests that prices are correlated with the previous data. This also supports the runs test by saying that the markets are inefficient in its weak form. The study concludes that the Indian stock markets are inefficient. This study is quite comprehensive consisting of various sectors and large enough sample size giving reliable conclusions.

Kilon & Jamróz (2015) **:** Series test, Autocorrelation tests and the augmented Dickey Fuller test were used to assess the Informational efficiency of Polish Markets and Baltic countries' Financial Markets. Very little and mild evidence against Weak form efficiency was found, with low values of autocorrelation and only a handful of them being statistically different from zero. Few indices showed a great degree of similarity to the random walk model signifying efficiency in weak form. 9 different indices were tested using the Runs tests and very clearly 4 out of them rejected the Hypothesis of Weak Form efficiency at very high significance levels. The mixed results found for various indices do not let us unambiguously conclude either for or against weak form efficiency. The paper also sheds light on the existence of transaction costs which could probably have led to mild autocorrelation and evidence against weak form efficiency. After accounting for such transaction costs, it might not be possible to earn an above average excess return.

Divyang Joshi (2012) : This study tests Weak Form Efficiency in BSE using 6 indices. It uses 10 years of data (2001 to 2010) for 4 indices which are BSE 30, BSE 100, BSE 200, BSE 500 and 8 years of data for BSE Mid Cap and BSE Small cap Index. This study uses the Runs Test to test the randomness of the prices. The test gives the p values of 0.000 for the 10 years of data which gives us sufficient evidence to conclude that the data are not in random order and the market is weak form efficient in the long run for each of the above-mentioned indices. The Runs test was again conducted on the one-year wise data of BSE 30 and BSE 100. The result was different. The result showed that the markets were efficient in a few years. Therefore, the study concluded that the Indian Stock Market is inefficient in the long run but weak form efficient in the short run.

Kumar & Lalit Kumar (2015) : The efficiency level of NIFTY 50 was tested using 4 years of data. The Autocorrelation runs test was performed on 2 indices. The results showed that the indices do not follow random walk, and are serially correlated resulting in weak form inefficient markets.

Islam et al. (2006) **:** In this paper, the researchers have tested the emerging Financial Market of Thailand using Runs test and Autocorrelation tests. The researchers aim to study the effect of the devaluation in the Thai Baht on the Financial market efficiency. The data under consideration runs from 1992 to 2001. It was seen that there is persistent strong positive correlation from both the runs test and the autocorrelation test violating weak form efficiency. The study considered 100 lags under the ACF test and it was concluded that there was significant autocorrelation in both the pre and post exchange rate crisis period.

Shiller & Radikoko (2014) **:** This study tests the weak form efficiency of Toronto Stock Exchange and compares the results to the comparative studies of exchanges like NYSE, LSE, TSE and NASDAQ. The study uses autocorrelation function, Breusch-Godfrey test, runs test, Augmented Dickey Fuller test and Phillips-Perron test to analyse the data. Runs test, BG test and Box Pierce test conclude that the market is inefficient. The null for the ADF and the PP tests is the presence of a unit root, whereas the null for the KPSS test is level stationarity. The ADF and the PP tests reject the null of a unit root, whereas the KPSS tests fail to reject the null of level stationarity for all index returns. Results of this study contradict our expectation of an efficient TSX equity market and suggest that Canadian index equity returns possess properties of a deterministic nonlinear weakly trend-reversing process.

Anand (2003) : This study uses data from January 1996 to June 2002 to analyse the weak form efficiency of Indian stock markets. The study uses Runs test and autocorrelation function on 3 indices namely CNX Defty, CNX Nifty and CNX Nifty Junior. The Autocorrelation test indicated that the markets are not weak form efficient but the Runs test gave contradicting results. The Runs test shows that CNX Defty and CNX Nifty are weak form efficient. The study concludes that we cannot strongly say that the markets are inefficient but there is scope for investors to earn abnormal returns through proper analysis.

Research Gap

All of the above papers analyse the efficiency of the stock market but no paper has analysed the efficiency during the covid 19 pandemic. The objective of the paper is to check the efficiency of the Indian stock market during this crisis and see how investor behaviour changes. Evaluating the same helps investors decide which type trading analysis to use depending on varying information sets to generate abnormal returns.

Hypothesis:

H_0: Prices follow random walk; technical analysis cannot be used and markets are efficient in the weak form.

H_1: The Indian stock market is not weak form efficient. One can use past price patterns to make trades, there exists arbitrage opportunities. Also due to the mutually inclusive efficiency sets, the market is not efficient in both semi strong and strong form.

Research Methodology:

To assess the market efficiency levels, we carry the following statistical tests using daily data of the above-mentioned Indices for a period of 15 months.

1. The prices follow a Random walk, for which a Runs Test needs to be performed to check for randomness.
2. No serial Autocorrelation in Stock Prices, we use Autocorrelation Functions, Box Pierce Test and Correlograms.

Analysis

The Runs Test

The Runs test, which is also known as Geary

test is used to determine if all observations are independent of each other by testing the randomness of the observations, we use this test to check if the prices follow random walk. It is conducted by taking data and counting the runs above and below the threshold. Run is basically a sequence of one symbol such as + or -, i.e. a series of increasing or decreasing values. Here, threshold is the median of the given data. A small number of runs with long lengths indicates positive serial correlation and too many runs signify negative serial autocorrelation. The assumptions of this test are that the mean and variance are constant and the probability is independent.

H_0: Stock Prices follow Random Walk, prices on successive dates are independent
H_1: Otherwise (Non-randomness, violation of Weak Form Efficiency)

$$Z\ stats = \frac{R - \underline{R}}{S_R} \quad \sim N(0,1)$$

$E(R) = \frac{2N_0N_1}{N} + 1$

$V(R) = \frac{2N_0N_1(2N_0N_1 - N)}{(N)^2(N-1)}$

$N = N_0 + N_1$
N_0 = number of + residuals
N_1 = number of – residuals
R = number of runs

Rejection Rule: If the Z stats is greater than the Critical value at α significance level, then we reject H_0 and conclude that Stock Prices do not follow Random walk, violating Weak form efficiency.

Rejection Rule at 5% Significance Level

Autocorrelation Function, Correlograms and Box Pierce Test

Serial Autocorrelation implies that a term is correlated with its lagged values. Presence of autocorrelation in the model leads to biased standard errors and hence the conventional tests stand invalid. Therefore, we conduct an Autocorrelation test (ACF) to detect the presence of autocorrelation.

Correlogram is a visual representation of serial correlation in a data, i.e. a plot of r_k against k. If a consistent upward or downward pattern is seen in the graph then the data exhibits serial correlation. In case a Series is Stationary the Autocorrelation Function converges to zero as the lag tends to infinity.

For prices to follow randomness, a necessary condition is that there is a lack of serial autocorrelation, i.e. there is autocorrelation of current prices with lagged values that must not be statistically different from zero. We use the Box-Pierce test to ascertain if the autocorrelation at various lags is statistically significant and different from zero or not. The Box-Pierce test is as follows, whereby under the null hypothesis there is no significant autocorrelation up to k'th lag indicating that the stock prices are not auto correlated and hence the markets are weak form efficient.

H_0: $\rho_1 = \rho_2 = \rho_3 \ldots = \rho_k = 0$, Correlation doesn't exist
H_1: Otherwise (at least one ρ_k is non zero, hence violation of weak form efficiency)

$$\rho_k = \frac{\gamma_k}{\gamma_0}$$

$$Q\ stats = n\sum_{k=1}^{m} \hat{\rho}_k^2 \ \approx\ \chi_m^2$$

m = lag length
n = sample size
Rejection Rule: If the Q stats is greater than the Critical value at α significance level, then we reject H_0 and conclude that Stock Prices do not follow Random walk as there is some serial autocorrelation. This suggests that one can use past prices to exploit arbitrage opportunities violating Weak form efficiency.

Results:

We have performed the Runs Test, Box Pierce Test and have also calculated the Autocorrelation Function and Correlograms using secondary data of the closing prices of the above mentioned 10 Indices. The data for the same has been collected from various websites namely https://finance.yahoo.com/, https://www.bseindia.com/Indices/IndexArchiveData.html and https://www1.nseindia.com/products/content/equities/indices/historical_index_data.html

It can be seen from the following table that all the test statistics are negative indicating that stock prices exhibit positive serial correlation. We also observe that the resulting p value for all the 10 indices under consideration is 0.000 and the same is smaller than α level of 0.01. This leads us to reject H_0 (whereby stock prices are

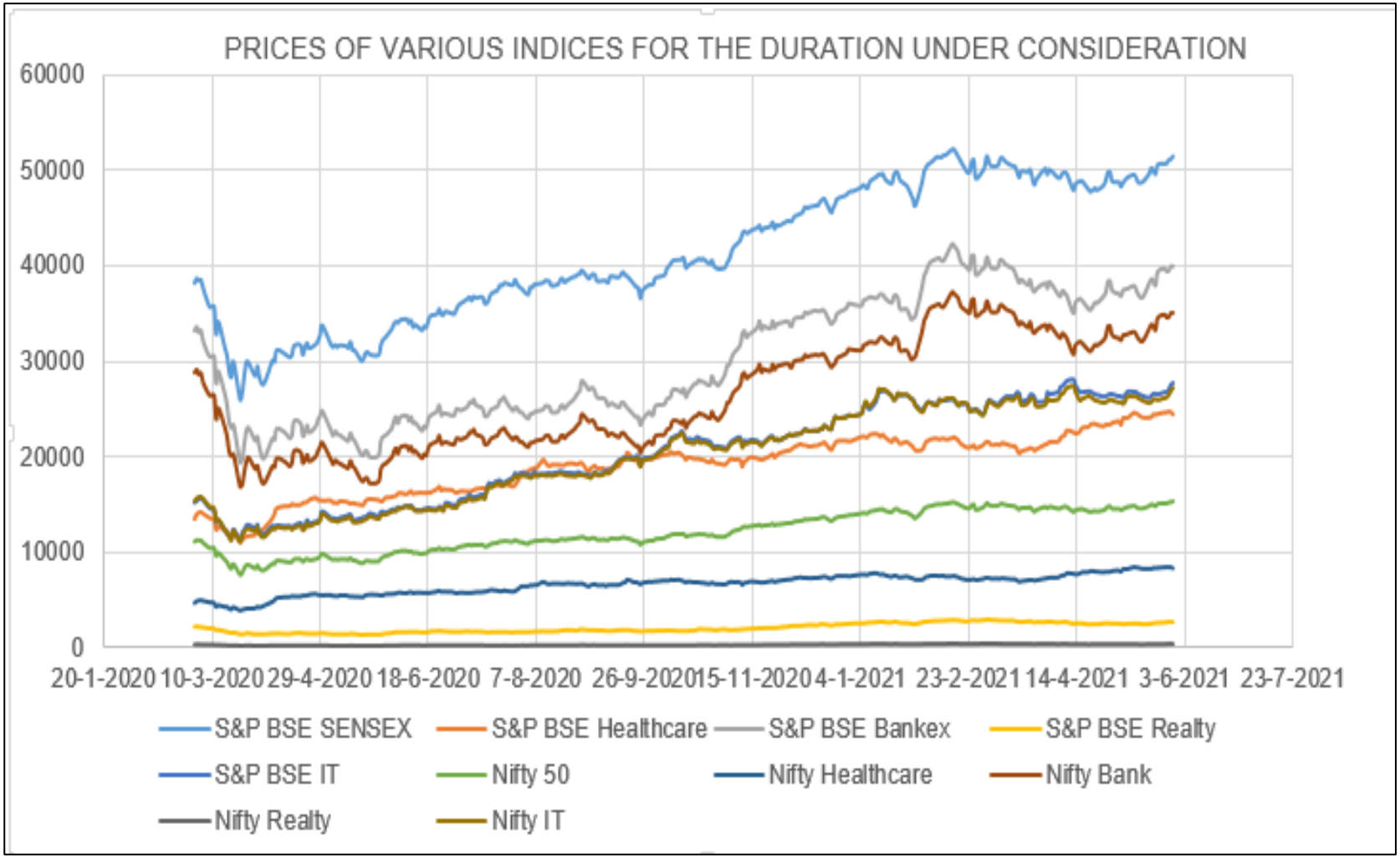

Figure 1: Price Trends

Name of the Index	Test Statistic	Runs	Number of + Residuals	Number of - Residuals	Total Observations	p-value
S&P BSE SENSEX	-16.949	6	153	153	306	0.0000
S&P BSE Healthcare	-16.262	12	153	153	306	0.0000
S&P BSE Bankex	-16.376	11	153	153	306	0.0000
S&P BSE Realty	-16.376	11	153	153	306	0.0000
S&P BSE IT	-17.178	4	153	153	306	0.0000
Nifty 50	-16.949	6	153	153	306	0.0000
Nifty Healthcare	-16.033	14	153	153	306	0.0000
Nifty Bank	-16.376	11	153	153	306	0.0000
Nifty Realty	-16.605	9	153	153	306	0.0000
Nifty IT	-17.178	4	153	153	306	0.0000

Figure 2: Runs Test

Lags	BSE Sensex	BSE Healthcare	BSE Bankex	BSE Realty	BSE IT	Nifty 50	Nifty Healthcare	Nifty Bank	Nifty Realty	Nifty IT
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	0.992	0.987	0.990	0.993	0.993	0.992	0.985	0.990	0.992	0.993
2	0.984	0.974	0.980	0.985	0.985	0.984	0.971	0.980	0.984	0.986
3	0.977	0.961	0.970	0.976	0.979	0.976	0.957	0.971	0.975	0.980
4	0.969	0.948	0.960	0.969	0.972	0.969	0.942	0.961	0.966	0.974
5	0.962	0.935	0.949	0.961	0.966	0.961	0.927	0.950	0.958	0.967
6	0.952	0.920	0.937	0.953	0.958	0.951	0.911	0.938	0.948	0.960
7	0.944	0.905	0.927	0.945	0.951	0.943	0.894	0.929	0.940	0.954
8	0.935	0.887	0.917	0.937	0.943	0.933	0.974	0.919	0.931	0.945
9	0.925	0.871	0.906	0.929	0.934	0.923	0.856	0.908	0.923	0.937
10	0.916	0.854	0.895	0.922	0.926	0.914	0.836	0.898	0.916	0.929
11	0.907	0.838	0.886	0.915	0.917	0.905	0.817	0.889	0.908	0.921
12	0.899	0.818	0.878	0.908	0.908	0.896	0.797	0.881	0.900	0.912
13	0.890	0.801	0.869	0.900	0.899	0.887	0.776	0.872	0.892	0.903
14	0.881	0.783	0.859	0.892	0.890	0.877	0.753	0.862	0.884	0.894

Figure 3: Autocorrelation function

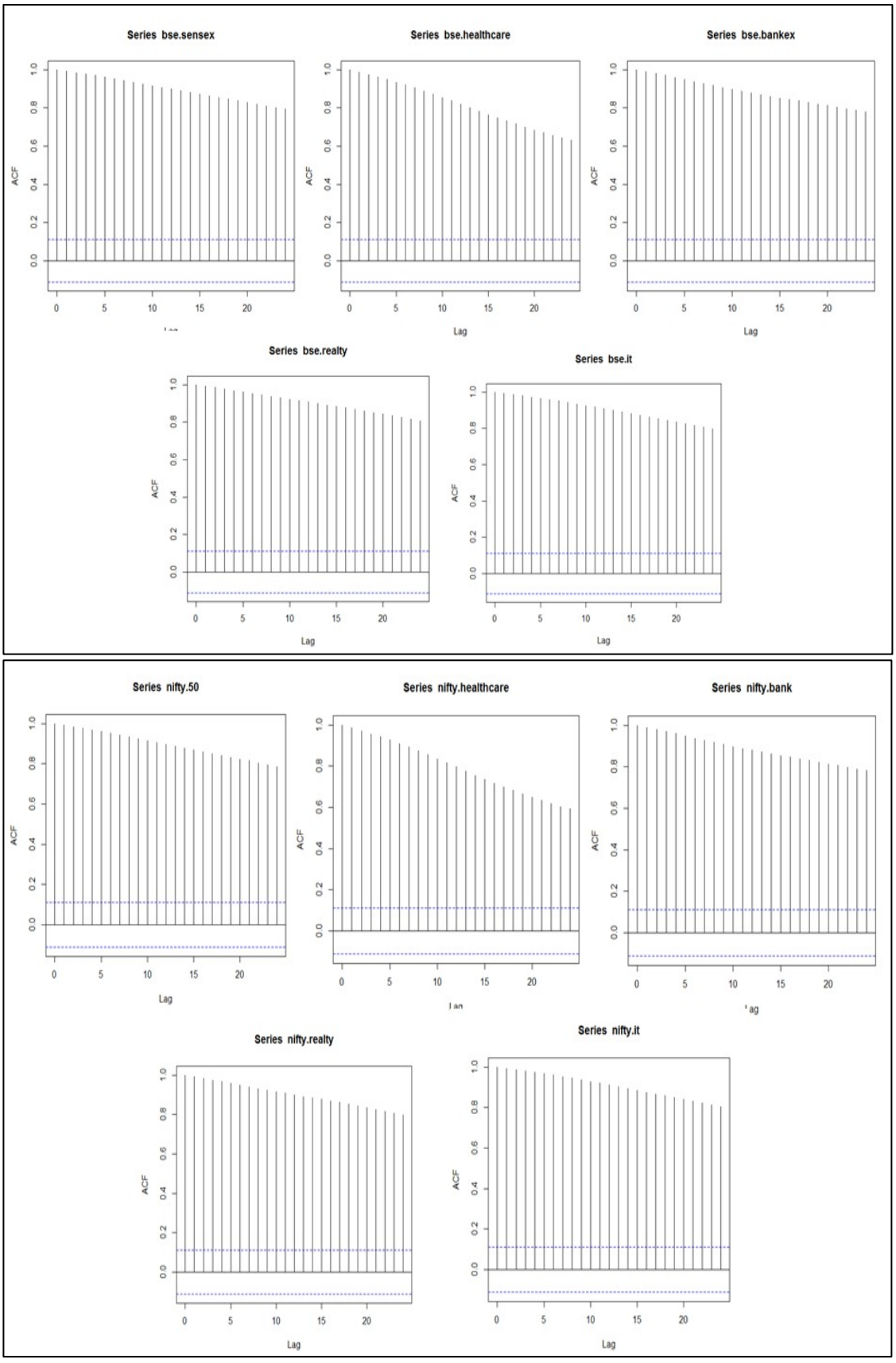

Figure 4: Correlogram II

generated randomly) at 1% and conclude that stock prices are non-random. This is clearly evidence against weak form efficiency of Indian Financial Markets, as all past information has not been absorbed in and accounted for in the price levels.

From the following table and graphs there tends to be clear and strong positive interdependence in current and past stock prices, as the serial autocorrelation of current prices with its immediate next lagged value is almost as high as 0.99 for all of the 10 Indices. This indicates that investors can earn above average excess returns based on technical analysis. But to formally assess the statistical significance we carry out the Box Pierce test accounting for 14 lags in the stock prices of the 10 Indices under consideration, the results are shown in figure 5.

The Q statistic (to test for the joint significance of serial autocorrelation upto 14 lags) for all of the above indices stands to be very large leading to a p value of 0.000 which is indeed lesser than the alpha level of 0.01. Once again, we reject the null hypothesis of no serial autocorrelation up to 14 lags. The results of all of the tests performed are compatible with one another and do not lead to contradicting results.

Limitations

- The study is confined to 10 Indices only
- The data used is only 15 months
- The study doesn't explicitly focus on the cause of Weak form inefficiency and the behavioral aspects of it.

Conclusion

As we know in times of crisis investors react turbulently and reallocate their portfolios to avoid any catastrophe which in turn leads to increased volatility and Risk in the Financial markets. Hence, we've tested the efficiency levels of Indian financial markets during the Covid 19 Pandemic and Lockdown crisis, accounting for few major indices of both BSE and NSE which would reflect the sectors that are most affected by the pandemic. On the basis of empirical evidence gathered by performing the Runs test and autocorrelation functions, we can conclude that the Indian Stock Markets are not Weak Form Efficient for the period under consideration.

Name of the Index	Test Statistic	Degree of Freedom/ Lags	p-value
S&P BSE SENSEX	3787.1	14	0.0000
S&P BSE Healthcare	3435.4	14	0.0000
S&P BSE Bankex	3669.4	14	0.0000
S&P BSE Realty	3815.9	14	0.0000
S&P BSE IT	3837.7	14	0.0000
Nifty 50	3775.3	14	0.0000
Nifty Healthcare	3339.4	14	0.0000
Nifty Bank	3683.5	14	0.0000
Nifty Realty	3778.8	14	0.0000
Nifty IT	3856.3	14	0.0000

Figure 5: Box Pierce Test

The Runs test rejects the presence of a random walk and autocorrelation test shows strong correlation between the present prices and its lagged values. This means that the current prices are strongly interdependent on the past prices which again points to the inefficiency of the markets. Our research reaffirms the conclusions of many other studies done previously on the Indian Stock Market such as (Devansh Jain et al., 2020) (Patel et al., 2018), (Sachin K & Sanningammanavara, 2014), (Divyang Joshi, 2012), etc. The practical

implications are that the stock prices don't reflect the true intrinsic value of the stock due to market inefficiency. Investors can utilize this mispricing to their advantage and apply technical analysis and trading rules based on past trends to generate abnormal returns. Not only is the use of technical analysis still valid to avail excess returns, but investors can go on to use both Fundamental analysis and insider information to make abnormal returns as well, this is so a weak form efficiency is a prerequisite for both semi strong and strong form efficiency.

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