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Testing Weak Form of Market Efficiency During Pandemic

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ABSTRACT

Is it possible to make profits in stock market? Whether the modern economic system is entrenched for egalitarian society? One of the propositions of current economic system: 'Efficient Market Hypothesis' imports that financial markets are "Informationally efficient", means the current market price of the stocks reflect all the available information. Hence, this study investigates the weak-form efficiency during pandemic for the stocks listed in Bombay Stock Exchange, the study is done considering the data from January 2020 to April 2021, includes total observation of 331. The study is done by understanding whether stock price changes are random or is it possible to predict using historical data. The examination of the weak-form efficiency is exercised using Kolmogorov–Smirnov test, Runs Test and Autocorrelation Test. The KS test reveals that 25 companies out of 30 companies stock price changes are not normally distributed. The outcome of Runs Test reveals that stock value of 29 companies out of 30 companies follow random-walk. The Autocorrelation test renders that the changes in the price of stocks are independent. Hence, the study favour that it is difficult for a trader to use past prices to predict the future price and to make additional profit during pandemic.

Introduction

In 1965 Eugene Fama discussed about "Random Walks in Stock Market Price" (Fama, 1995), even today the studies are carried out to test the existence of random walks at different market conditions (Brown, 2020).

An efficient market is a market where the stock prices will be trading at fair value or intrinsic value. The "Efficient-Market-Hypothesis" (EMH), is informationally efficient market (Fama E. F., 1970). When the financial markets are efficient in terms of information, it means the present market price of the stock consider all the

information available at that point of time. "An Efficient-Market-Hypothesis can be in the form of "Weak", "Semi-Strong" and "Strong" form (Fama E. F., 1970). In Weak-form of EMH the current market prices are already discounted for all the past information, in Semi-Strong form of EMH the prices are already discounted for the all the past information and publicly available information and in Strong form of EMH the prices are already discounted for all the past, publicly available and private information.

There are innumerable studies investigated considering different stock markets from various economy to find out the validity of random walk hypothesis. Some have revealed that the weak and semi strong form of EMH is existing in developed and emerging economy's stock markets, which means stock prices are not predictable. Recent studies have disclosed that the EMH is not existing in any of the stock markets which means stock market prices are predictable (Iqbal & Mallikarjunappa, 2010). A study which finds the confirmation to support the weak-form of efficiency and some other studies reveal the confirmation of rejecting the random walk hypothesis in stock prediction. The mixed results of the earlies studies of random walk hypothesis has made us to revisit to the issue of weak-form-efficiency at this pandemic situation by considering Indian stock market.

The current study is to investigate the weak-form of EMH of the stocks listed on Bombay Stock Exchange (BSE) for the period from January 2020 to April 2021. The BSE was established in 1875 by calling it as The Native Share & Stock Brokers. BSE was the 1st stock exchange to start in Asia and the present speed of response is 6 micro seconds, which is the fastest in the world. BSE is the 1st Indian stock exchange to list in Indian stock market. The market capitalization of BSE at the end of February 2021 was ₹ 2,07,86,137 Crores with more than 4,300 listed companies. The data for the study is related to 30 constituent companies of BSE (Sensex) to proxy the BSE whole.

REVIEW OF LITERATURE:

There are various studies conducted to test the existence of Efficient Market Hypothesis among developed and emerging markets. The efficient market can be based on stock market returns, where the returns are random and the participants cannot earn additional return in an efficient market (Degutis & Novickytė, 2018). The Weak and Semi-Strong form of efficiency is not existing in Indian Stock Market (N & Ananzeh, 2014) (Iqbal & Mallikarjunappa, 2010). The Bahrain Bourse revealed the mixed results for weak form of efficiency (Hawaldar, Rohit, & Pinto, 2017). It is possible to predict the stock prices using predetermined variables along with components of stock prices (Stambaugh, 1986). The return on long term holdings can be predicted using historical returns (Fama & French, Permanent and Temporary Components of Stock Prices, 1988).

It is noteworthy that "the Random Walk Hypothesis is not followed in Gulf market's stock price movements" (Awan & Subayyal, 2016). Similarly, in GCC Stock Market it follows normal distribution, implying Random walk is not followed (Meero, 2018). In Indian Stock Market also, using daily observations from July 2007 to December 2011, it is highlighted that well diversified portfolios improve returns, entailing the random walk hypothesis is not existing (Jayakumar G S & Sulthana A, 2013).

Another study, using Weekly data (1962-1985), rejects the Random Walk hypothesis by articulating that if the frequency of trading is not continuous it cannot be accounting for the magnitude of established autocorrelation of returns generated on weekly basis (Lo & MacKinlay, 1988).

Again in 15 African markets (2010-18), the market returns series are stationary, which means these markets won't follow Random Walk Hypothesis" (Kelikume, Olaniyi, & Iyohab, 2020).

Inferences from sporadic studies with different terms, deploying hetero-tools for research to the existence of Weak-Form of EMH is elusive in various markets. In this backdrop, the inquiry of testing Weak-Form of Efficiency on BSE during the inflicted term of global pandemic shocks is scientifically futuristic for the investors' community.

OBJECTIVES OF THE STUDY:

- To test the weak-form-efficiency of stocks listed on BSE during pandemic.
- To test the randomness of stock price movement during pandemic.
- To examine the Independence of price-change during pandemic.

HYPOTHESES:

After considering the reviews from literature following hypotheses are framed for the study.

H_0 1: *The prices of every stock in BSE does not follow weak-form efficiency*
H_1 1: *The prices of every stock in BSE follow weak-form efficiency*
H_0 2: *Past price changes will not have any impact on future price predictions.*
H_1 2: *Past price changes will have impact on future price predictions.*
H_0 3: *The change in stock price movement are not independent*
H_1 3: *The change in stock price movements are independent*

RESEARCH METHODS:

The daily closing prices of 30 constituents of BSE Sensex give rise to the sample set for the study. As the core objective of the study is being the investigation of 'Weak form of Efficient Market Hypothesis during pandemic', the entire list of companies in BSE has been kept as Sample Frame to draw representatively the same of thirty constituent companies.

The investigation of 'Weak form of Efficient Market Hypothesis' is done by considering the daily closing prices for the selected thirty companies, the data is collected from January 2020 to April 2021.

"The stock returns are defined as daily log returns" (Hawaldar, Rohit, & Pinto, 2017)

$$R_t = \frac{Log_{pt}}{Log_{pt-1}}$$

Where R_t is the return at time *t*, Log_{pt} is logarithmic price at time *t* and Log_{pt-1} is the logarithmic price at time *t-1*

"The study analyses and investigates the weak-form of efficiency of individual stock price changes. The Weak form EMH is investigated using the Kolmogorov–Smirnov (KS) goodness of fit test, runs test and autocorrelation test" (Hawaldar,

Rohit, & Pinto, 2017) (Meero, 2018).

Kolmogorov–Smirnov goodness of fit test: KS test compares the observed cumulative distribution function for a variable with a specified theoretical distribution, which may be normal, uniform, Poisson or exponential" (Elango & Hussein, 2007). "KS goodness of fit test is used to find out whether the returns follow normal distribution or not" (Hawaldar, Rohit, & Pinto, 2017). The objective of the study is to investigate whether stock price changes follow normal distribution or not, the results KS test will reveal whether stock price changes follow normal distribution or not.

Runs Test: "The runs test is a nonparametric test employed to investigate the serial dependence of the stock market returns. The advantage of this test is that it ignores the properties and nature of the series distribution. The principle for this test is based on the identification f the series of increasing values and the series of decreasing values. The number of increased and decreased series is called the RUN. The observed number of runs is compared to the expected number of runs to evaluate if the series distribution is following the random walk or not. The significance value for a 95% interval of confidence leads to the acceptance or the rejection of the hypotheses" (Meero, 2018).

For Runs Test, the *mean* and *variance* is calculated as follows:" (Hawaldar, Rohit, & Pinto, 2017)

$$\mu = \frac{2n_1 n_2}{n_1 + n_2} + 1 \quad (1)$$

$$\sigma^2 = \frac{2n_1 n_2 (\, 2n_1 n_2 - n_1 - n_2)}{(n_1 + n_2)^2 \, (n_1 + n_2 - 1)} + 1 \quad (2)$$

Autocorrelation Test: "To test the independence of stock returns series the autocorrelation test is used. This test is used to determine the inter correlation between stock return values in the series with different lag numbers" (Meero, 2018). "A higher value of autocorrelation indicates greater correlation in values and proposes that by using a less restrictive condition of sub martingale sequence, low serial correlation may persist in an efficient market" (Fama E. F., 1970).

DISCUSSION

Table *1*: Descriptive Statistics Value of Stock Returns displays the descriptive statistics data of the log returns for the BSE SENSEX constituent companies listed on BSE. 23 companies have reported a positive mean return for the selected period and other 7 companies i.e Axis Bank, HDFC, Indusind Bank, ITC, Maruti, NTPC and ONGC reported a negative mean return. Infosys records the highest mean returns of 0.0795%. Indusind Bank is having a highest risk among all the stocks with a standard deviation of 2.17721% whereas Nestle has a lowest risk among all the stocks with a lowest Standard Deviation of 0.83683 among all the stocks for the period of study.

Table 1: Descriptive Statistics Value of Stock Returns

Stock Name	N	Mean	S D (%)	Minimum	Maximum

Asian Paints	331	0.0458	0.95068	-6.63	3.71
Axis Bank	331	-0.0063	1.63894	-14.28	7.7
Bajaj Auto	331	0.0257	1.00225	-6.53	4.94
Bajaj Finance	331	0.0334	1.62376	-11.67	4.38
Bajaj Finserve	331	0.0214	1.47475	-13.34	4.62
Bharti Airtel	331	0.0224	1.11605	-5.62	4.66
D rReddy	331	0.0768	0.92543	-2.55	5.67
Hcl Tech	331	0.0594	1.03016	-3.85	4.75
HFDC Bank	331	0.0128	1.07932	-5.89	4.83
HDFC	331	-0.0009	1.25314	-5.98	4.27
HUL	331	0.0256	0.86752	-3.98	5.51
ICICI Bank	331	0.0147	1.40227	-8.55	5.62
Indusind Bank	331	-0.0606	2.17721	-11.86	16.16
Infosys	331	0.0795	1.00769	-4.56	5.19
ITC	331	-0.0212	1.00986	-5.58	3.5
Kotak Bank	331	0.0057	1.18030	-6	5.04
LNT	331	0.003	1.07527	-7.73	3.97
MNM	331	0.0445	1.29742	-4.23	6.72
Maruti	331	-0.016	1.19756	-8.1	5.47
Nestle	331	0.0129	0.83683	-3.9	5.06
NTPC	331	-0.0224	1.00006	-3.81	3.31
ONGC	331	-0.0209	1.42804	-7.86	7.4
Power Grid	331	0.0153	0.96446	-5.2	2.91
RIL	331	0.0367	1.18349	-6.23	5.94
SBIN	331	0.0074	1.29970	-6.24	5.64
Sun Pharma	331	0.0539	0.98225	-5.27	4.52
TCS	331	0.0445	0.91132	-4.31	4.1
TechM	331	0.0308	1.08801	-7.01	3.61
Titan	331	0.0335	1.05404	-5.54	4.58
Ultra Tech	331	0.057	1.04948	-6.86	5.31

Source: Results of SPSS using the stock data from www.bseindia.com

***Kolmogorov–Smirnov goodness of fit test**:*

H_0 1: The prices of every stock in BSE does not follow weak-form efficiency

H_1 1: The prices of every stock in BSE follow weak-form efficiency

The investigation results of KS test is depicted in ***Table 2: Results of K-S Test Results of K-S Test***. The K-S test results reveal that *p*–Value of 25 stocks out of 30 stocks is ≤ 0.05, which is significance at 5% level, it shows that the frequency distribution of the daily closing prices of the stocks does not fit into normal distribution, therefore, by rejecting the null hypothesis it can be concluded the prices of every stock in BSE follow weak-form efficiency.

Table 2: Results of K-S Test

Stock Name	*p* - Value	Stock Name	*p* - Value
Asian Paints	0.061*	Kotak Bank	0.009*

Axis Bank	0.004*	LNT	0.001*
Bajaj Auto	0.001*	MNM	0.005*
Bajaj Finance	0.003*	Maruti	0.001*
Bajaj Finserve	0.002*	Nestle	0.003*
Bharti Airtel	0.029*	NTPC	0.316*
Dr Reddy	0.002*	ONGC	0.007*
Hcl Tech	0.021*	Power Grid	0.064*
HFDC Bank	0.074*	RIL	0.002*
HDFC	0.016*	SBIN	0.019*
HUL	0.002*	Sun Pharma	0.190*
ICICI Bank	0.025*	TCS	0.007*
Indusind Bank	0.000*	TechM	0.006*
Infosys	0.008*	Titan	0.020*
ITC	0.002*	Ultra Tech	0.035*

Source: Results of SPSS using the stock data from www.bseindia.com
*Note: *significant at 5% level*

Runs Test:

H_0 2: Past price changes will not have any impact on future price predictions.
H_1 2: Past price changes will have impact on future price predictions.

The results of Runs test conducted for BSE SENSEX constituent companies is appearing in Table 3 Results of Runs ***Tests***. The p-value of Kotak Bank is ≤ 0.05 and Z value are greater than critical value of ±1.96, and p-value of other 29 companies are > 0.05. Since p-value of 29 companies out of 30 companies is >0.05, do not reject the null hypothesis and it can be concluded that past price changes will not have any impact on the future price prediction and price changes follow the random walk model.

Table 3 Results of Runs Tests

Stock Name	Test Value	Cases < Test Value	Cases >= Test Value	Total Cases	Number of Runs	Z - Value	*p* - Value
Asian Paints	0.09	165	166	331	169	0.275	0.783*
Axis Bank	0.08	165	166	331	166	-0.055	0.956*
Bajaj Auto	0.02	163	168	331	171	0.500	0.617*
Bajaj Finance	0.07	163	168	331	154	-1.372	0.170*
Bajaj Finserve	0	163	168	331	152	-1.593	0.111*
Bharti Airtel	0	164	167	331	180	1.488	0.137*
Dr Reddy	0.01	164	167	331	180	1.488	0.137*
Hcl Tech	0.06	165	166	331	172	0.606	0.545*
HFDC Bank	-0.02	165	166	331	158	-0.936	0.349*
HDFC	0.03	165	166	331	160	-0.715	0.474*
HUL	-0.04	164	167	331	172	0.607	0.544*
ICICI Bank	0.14	165	166	331	168	0.165	0.869*
Indusind Bank	-0.08	165	166	331	156	-1.156	0.248*
Infosys	0.05	165	166	331	167	0.055	0.956*
ITC	-0.06	162	169	331	172	0.614	0.539*

Kotak Bank	0.01	165	166	331	185	2.037	0.042*
LNT	0	164	167	331	154	-1.375	0.169*
MNM	0.05	163	168	331	172	0.610	0.542*
Maruti	0	161	170	331	166	-0.042	0.967*
Nestle	-0.06	162	169	331	179	1.385	0.166*
NTPC	-0.07	165	166	331	172	0.606	0.545*
ONGC	0.08	165	166	331	165	-0.165	0.869*
Power Grid	0	162	169	331	181	1.605	0.108*
RIL	0.05	164	167	331	166	-0.054	0.957*
SBIN	0.07	164	167	331	166	-0.054	0.957*
Sun Pharma	0.02	165	166	331	183	1.817	0.069*
TCS	0.02	163	168	331	165	-0.161	0.872*
TechM	0.12	165	166	331	178	1.266	0.205*
Titan	0.04	165	166	331	171	0.496	0.620*
Ultra Tech	0.06	164	167	331	170	0.387	0.699*

Source: Results of SPSS using the stock data from www.bseindia.com
*Note: *significant at 5% level*

Autocorrelation Test:

H_0 3: The change in stock price movement are not independent

H_1 3: The change in stock price movements are independent

Table 4 Results of Autocorrelation of Individual Stocks

Company	Lag → 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Asian Paints	0.004	0.017	0.015	0.023	0.036	0.045	0.009	0.012	0.011	0.017	0.015	0.024	0.031	0.034	0.036	0.045
Axis Bank	0.787	0.955	0.98	0.972	0.932	0.899	0.688	0.657	0.745	0.689	0.458	0.486	0.552	0.343	0.4	0.231
Bajaj Auto	0.084	0.222	0.38	0.406	0.508	0.525	0.332	0.431	0.444	0.537	0.45	0.456	0.467	0.544	0.454	0.345
Bajaj Finance	0.648	0.899	0.968	0.72	0.156	0.003	0.001	0	0	0	0	0	0	0	0	0
Bajaj Finserve	0.958	0.989	0.952	0.219	0.171	0.124	0.031	0.009	0.016	0.017	0.021	0.005	0.006	0.009	0.012	0.018
Bharti Airtel	0.088	0.047	0.102	0.182	0.152	0.19	0.207	0.222	0.249	0.297	0.377	0.372	0.45	0.526	0.561	0.577
Dr Reddy	0.766	0.948	0.762	0.81	0.902	0.939	0.888	0.913	0.951	0.967	0.898	0.935	0.955	0.896	0.928	0.939
Hcl Tech	0.069	0.155	0.105	0.168	0.102	0.05	0.008	0.013	0.016	0.016	0.021	0.025	0.028	0.041	0.046	0.014
HFDC Bank	0.664	0.348	0.373	0.359	0.084	0.008	0.009	0.01	0.012	0.02	0.009	0.012	0.015	0.023	0.03	0.021
HDFC	0.648	0.102	0.024	0.047	0	0	0	0	0	0	0	0	0	0	0	0
HUL	0.003	0.007	0.008	0.006	0.013	0.003	0	0	0	0	0	0	0	0	0	0
ICICI Bank	0.3	0.549	0.665	0.736	0.019	0	0.001	0.001	0.002	0.002	0	0	0	0	0	0
Indusind Bank	0.031	0.024	0.028	0.01	0.021	0.015	0.024	0.023	0.007	0.013	0.01	0.015	0.021	0.014	0.021	0.027
Infosys	0.053	0.054	0.078	0.078	0.035	0.002	0.001	0.001	0	0	0.001	0.001	0.001	0.001	0	0
ITC	0.663	0.345	0.312	0.301	0.002	0	0	0	0	0	0	0	0	0	0	0
Kotak Bank	0.783	0.704	0.645	0.794	0.891	0.044	0.054	0.079	0.118	0.127	0.081	0.097	0.104	0.141	0.174	0.202
LT	0.292	0.569	0.744	0.862	0.436	0.266	0.231	0.304	0.206	0.143	0.161	0.215	0.116	0.096	0.103	0.126
MNM	0.809	0.236	0.394	0.452	0.012	0.003	0.002	0.004	0.007	0.01	0.001	0.001	0.001	0.001	0.001	0.001
Maruti	0.119	0.285	0.463	0.247	0.317	0.2	0.186	0.158	0.206	0.263	0.007	0.006	0.01	0.009	0.012	0.013
Nestle	0.153	0.025	0.006	0.006	0.012	0.012	0.022	0.03	0.014	0.022	0.011	0.017	0.025	0.012	0.008	0.01
NTPC	0.842	0.826	0.85	0.875	0.652	0.017	0.021	0.025	0.04	0.051	0.051	0.071	0.069	0.081	0.098	0.126
ONGC	0.002	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Grid	0.149	0.315	0.336	0.216	0.326	0.062	0.1	0.146	0.198	0.24	0.298	0.231	0.192	0.14	0.182	0.169
RIL	0.028	0.059	0.089	0.128	0.014	0.009	0.001	0.001	0.001	0	0	0	0	0	0	0
SBIN	0.623	0.44	0.285	0.386	0.003	0	0	0	0	0	0	0	0	0	0	0
Sun Pharma	0.156	0.163	0.269	0.276	0.396	0.069	0.027	0.043	0.044	0.066	0.023	0.036	0.038	0.052	0.073	0.021
TCS	0.004	0.014	0.03	0.063	0.031	0.011	0.01	0.008	0.009	0.009	0.004	0.001	0.002	0.003	0.003	0.005
TechM	0.008	0.028	0.018	0.028	0.011	0.001	0	0	0	0.001	0.001	0.001	0.002	0.003	0.005	0.007
Titan	0.066	0.008	0.017	0.037	0.069	0.03	0.011	0.02	0.033	0.043	0.038	0.056	0.054	0.003	0.002	0
Ultra Tech	0.012	0.014	0.001	0.002	0.002	0	0	0	0	0	0	0	0	0	0	0

Source: Results of SPSS using the stock data from www.bseindia.com
*Note: * Significant at 0.05 level*

To investigate whether stock price movements are independent or not the

Autocorrelation Test has been conducted, Table 4 Results of Autocorrelation of Individual Stocks. demonstrates the results obtained from autocorrelation tests. The results are mixed, Asian paints, HUL, Indusind Bank, ONGC, TechM and Ultra Tech are having p-value of ≤ 0.05 throughout the 16 lags. Nestle and HDFC have p-value of ≤ 0.05 from lag 2 and lag 3 onwards respectively. ICICI Bank, Infosys, ITC, MNM, RIL and SBIN have p-value of ≤ 0.05 from lag 5 onwards. Bajaj Finance, Bajaj Finserve, HDFC Bank, Maruti, NTPC, Sun pharma, Hcl Tech, TCS and Titan have p-value of ≤0.05 during some lags. Axis Bank, Bajaj Auto, Dr. Reddy, LT and Power grid have p-value of >0.05 throughout 16 lags. The individual stock results are a mixed response the total lags of all the stocks are considered for concluding. Out of total lags of 480, 287 lags are having p-value of ≤0.05, which amounts to 59.79%. From this we can reject null hypothesis and conclude that the change in stock price movements are independent.

FINDINGS

From the study the following findings are drawn:

Test	Result	Remarks
K S Test	*p*–Value is significance at 5% level for 25 stocks.	It is found that the *p*–Value is ≤ 0.05 for 25 Stocks, which is significant at 0.05, it means the stock price changes are not normally distributed so, the weak form of Efficient Market Hypotheses is existing in BSE.
Runs Test	*p*-Value of 29 companies out of 30 companies are >0.05.	It is observed that *p*-Value of 29 companies is > 0.05 which is not significant at 0.05, so, the past prices will not any impact on the prediction of future prices and stock price changes follow random walk model.
Autocorrelation	*p* -Value of 287 out of 480 lags (59.79%) are having ≤ 0.05.	From the study it is found out that the *p*-Value of the 59.79% of the total lags are ≤ 0.05, which is significant at 0.05, therefore the changes of individual stock prices are not depending of past prices, and they are independent.

CONCLUSION:

The present research is done to investigate the existence of 'Weak Form of Efficient-Market-Hypothesis during pandemic" in Bombay Stock Exchange. The study is done by considering the constituents of BSE SENSEX. The data from January 2020 to April 2021 is considered for the study.

Infosys has the highest mean return of 0.0795, whereas HDFC records the lowest average return of -0.0009. From the Kolmogorov–Smirnov goodness of fit test results it can be concluded that stock price changes do not have normality and the weak form of efficiency is not existing. The results of Runs test show the consecutive price changes are irregular and price changes follow Random Walk Model. Autocorrelation tests reveals that stock prices changes are not depending on the past prices and they are independent.

The outcome of the test supports that the stock price movements do not have

normality. the price changes follow Random Walk Model and the prices changes are independent. Therefore, it can be concluded that the 'Weak Form of Efficient Market hypothesis is not existing in the stocks listed on Bombay Stock Exchange (BSE) during the pandemic.

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