Hypothesis Test of Weak Form of Market Efficiency in Some Selected Stocks

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Abstract

The present study attempted to examine the weak-form of market efficiency of a sample of 33 daily stock returns belonging to seven specific sectors in the National Stock Exchange of India for the period from May 18, 2020 – May 12, 2021. The study's objective was to examine normality and randomness in data series of stock returns for this period. In order to get the desired results, it used means, standard deviation, skewness, kurtosis, Jarque – Bera test, and runs test. The normality test results found that the data of 31 equity stock prices were not normally distributed except for the two stock prices. The outcome of the runs test was that the distribution of daily stock returns of 30 select companies followed a random walk and was the weak-form efficient market.

Keywords : **weak-form efficiency, normal distribution, random walk, Jarque – Bera test, and runs test**

JEL Classification Codes : C12, D53, G14

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An efficient market is a very important concept for investors. No investor can earn abnormal profit in such a market since all the information is disseminated, which promptly reflects the stock prices. Hence, the possibility of undervalued and overvalued assets is thin, giving greater or smaller expected returns. The true prices are reflected by the available information; the investors, brokers, and financial institutions can easily access all information relating to the assets (Khan et al., 2011). The term market efficiency is applied to illustrate the relationship between information and security price. Fama categorized the market into three types, namely weak-form, semi weak-form, and strong-form. There is a constant mean and no autocorrelation of prices in a weak-form efficient market. In other words, the current prices reflect the information pertaining to historical prices fully; hence, no investor can formulate the trading rule strategy to earn abnormal returns solely based on the behavior of the past prices (Yadav, 2019). A market is considered semi-strong when information includes publicly available information apart from private information. In other words, the market absorbs and reflects not only private information but also publicly available information. In such a market, investors cannot gain by analyzing only published data (Poshakwale, 1996). The strong form of market states that market prices quickly incorporate the private information or insider information that is known by any market participant. The insiders are not capable of using private information. As a result, they cannot develop a superior investment strategy that helps them earn an abnormal trading profit (Sharma & Chander, 2011).

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Literature Review

Fawson et al. (1996) observed the absence of autocorrelation in monthly share returns with randomness in the data order of closing share price. The study's empirical results revealed the efficiency of the Taiwan stock market in a weak form. Moustafa (2004) found that the distribution behavior of stocks in the UAE stock market during the period was not normal. It was also observed that of the 43 stocks, returns of 40 stocks followed randomness at a 5% significance level. Mlambo and Biekpe (2007) disclosed that the random walk of data order was rejected by significant stocks out of the 10 African stocks in the weak form efficient market excluding Namibia. The correlation with the JSE led to cause weak form efficiency of the NSX. Arora and Singh (2017) attempted to re-test the efficiency in weak form using high-frequency data and also wanted to exploit the intra-day predictability of the stock market. The examination results got evidence that the weak-form market efficiency was absent. Al-Jafari and Altaee (2011) found that the variance ratio disclosed a positive correlation in the daily return of the Egyptian market. The study results concluded that the market did not come in random order and was inefficient from the informational viewpoint.

Sharma (2013) found that 13 sector-specific indices in the NSE violated the normal distribution of sector indices. It was also observed that all the sectors had autocorrelation except the FMCG sector, and six sectors had market efficiency in the weak form. Sharma and Chander (2011) investigated the weak-form efficient market in three phases and observed that stock returns had no perfect autocorrelation function but independence of successive stock returns. It was also revealed that from the past value, the market had the least possibility to develop predictable behavior of stock returns. Ntim et al. (2007) concluded that stock returns did not show weak form efficiency from the perspective of the strict random walk or the relaxed martingale difference sequence sense. It further found that the non-parametric variance ratio test yielded conclusive results apart from the parametric alternative. Worthington and Higgs (2005) concluded that all Asian and developed markets were not efficient in weak form as suggested by serial correlation and runs test, but three unit root tests displayed the contrary excepting Australia and Taiwan. The stringent variance ratio test indicated that random walks did not characterize the emerging market, while the developed markets followed stringent random walk criteria. Banerjee and Mulligan (2010) found that their study followed the normality of the equity price series and confirmed the weak form of the efficient market hypothesis. Worthington and Higgs (2003) examined the market efficiency of the Latin American equity market in a weak form. The results of various parametric and non-parametric tests displayed that the random walk did not characterize any of the markets and, hence, these were inefficient in weak form. Tadoori and Vadithala (2021) analyzed the 44 major stock exchanges across the world by using Hurst exponent and variance test ratio to prove the adaptive market, that is, the randomness of the market.

Research Gap

After reviewing the previous study of the weak-form efficient capital market, one can gather some idea that most of these studies are associated with the different stock market indices across various countries. Besides, the statistical tests of these studies give varying results in efficient markets from one country to another in different times. Since the present time period differs from the period in which earlier studies have been conducted on account of the pandemic situation, it is interesting to choose this topic as a study to fill the existing literature gap. Hence, the present study is an attempt to examine the daily stock returns of the weak-form efficient/inefficient individual stocks during the pandemic period of the last one year.

Objective of the Study

The present study has been undertaken keeping in mind certain specific objectives given below :

- To examine the normal distribution of data in daily stock returns of select companies.
- To examine random walk of order of data in daily stock returns of select companies.

Hypotheses Development

The study has framed two hypotheses based on the literature review and objectives of the research.

- **H1 :** The data of daily equity stock returns of select companies is normally distributed.
- **H2 :** The distribution of daily stock returns of select companies follows random walk.

Research Methodology

The present investigation is empirical in nature. The secondary sources are the only basis of the present study, which were collected from the National Stock Exchange (NSE) website www.nse.com. For this study, the daily closing price of the individual stocks has been taken to get the daily stock returns. The study pertains to the period ranging from May 18, 2020 – May 12, 2021, on a daily basis. It has a total of 248 observations, excluding public and other holidays during this period. A total of 33 equity stock samples were drawn out of the total population of listed companies belonging to the seven sectors on the National Stock Exchange of India, excluding banking, IT, and health care industries. The first four/five aforesaid stocks were picked in a sequence order from the uploaded industry-wise list on the given website. The sample companies selected from the different sectors for this study are listed in Table 1. The data were analyzed and interpreted with the help of statistical software, namely Numxl and SPSS 23, in order to get the results.

Table 1. ***A Sample of Select Individual Company Stocks***

Stock No.	Companies	Sector
1	Britannia Industries Ltd.	Fast Moving Consumer Goods (FMCGs)
2	Colgate Palmolive (India) Ltd.	
3	Dabur India Ltd.	
4	Emami Ltd.	
5	Godrej Consumer Products Ltd.	
6	Amber Enterprises India Ltd.	Consumer Durable Goods
7	Bata India Ltd.	
8	Blue Star Ltd.	
9	Crompton Greaves Consumer Electricals Ltd.	
10	Dixon Technologies (India) Ltd.	
11	Amara Raja Batteries Ltd.	Automobile
12	Ashok Leyland Ltd.	
13	Bajaj Auto Ltd.	
14	Balkrishna Industries Ltd.	
15	Brigade Enterprises Ltd.	Construction
16	DLF Ltd.	
17	Godrej Properties Ltd.	

18	Indiabulls Real Estate Ltd.	
19	Alkem Laboratories Ltd.	Pharma
20	Aurobindo Pharma Ltd.	
21	Biocon Ltd.	
22	Cadila Healthcare Ltd.	
23	Cipla Ltd.	
24	Adani Total Gas Ltd.	Oil & Gas
25	Bharat Petroleum Corporation Ltd.	
26	Castrol India Ltd.	
27	GAIL (India) Ltd.	
28	Gujarat Gas Ltd.	
29	APL Apollo Tubes Ltd.	Metals
30	Adani Enterprises Ltd.	
31	Coal India Ltd.	
32	Hindalco Industries Ltd.	
33	Hindustan Zinc Ltd.	

At the initial stage of analysis of the efficient market, the closing price index of the stock is used to get the stock return. It is calculated by deducting the current closing prices of stocks from the previous closing price divided by the previous closing price. Mathematically, it can be expressed as :

Stock Return = Current Closing Price of Stock Previous Closing Price/ Previous Closing Price

Since the present study is concerned with the daily stock returns, a natural logarithm was applied to get daily stock returns, which is different from the general stock returns. The formula used for calculating the daily returns from the closing price of the stock is expressed mathematically as :

$$\text{Daily Stock Return} = \text{Ln}\,(P_t / P_{t-1}) \qquad (1)$$

The study used arithmetic mean to get the expected returns of all the stocks studied during the period. Further, the standard deviation was applied in order to know the volatility of all data series.

Normality Test

The distribution pattern of data has been observable by using the two measures of skewness (S) and kurtosis (K). The assessment of normality of data has been made through the Jarque – Bera test (J – B). It is a goodness of fit test to see whether the S and K of sample data match a normal distribution or not. In the normal distribution of data, the skewness is almost equal to zero and kurtosis three, respectively. In the normality test, a tiny *p*-value and large J – B value means that the null hypothesis can be rejected, which shows that the data distribution is normal. It is applied for large data sets on account of its reliability. The formula to test the normality of data in a time series is given as :

$$JB = n[S^2/6 + (K-3)^2/24] \qquad (2)$$

Here,

n = number of observations,

S = skewness,

K = kurtosis.

Randomness Test

In the present study, almost all the distribution of data follows a lack of normality; as a result, the necessity arises to test their randomness in the distribution patterns. The randomness of the data has been checked through the non-parametric runs test. A runs test is a statistical analysis to determine the randomness of data by revealing any variable which might influence the data patterns. This test can be a valuable tool for making decisions in case of technical analysis relating to the movement of return on investment. The results of the runs test in this study are that the *p*-value is small or equal to the 5% level of significance. One can reject the null hypothesis and conclude that the data order is random.

On the contrary, the *p*-value is more than the 5% level of significance. One can accept the null hypothesis and conclude that the data order is non-random. The distribution of mean and variance of runs test can be expressed as:

$$\text{Mean}: E(R) = (2N1N2/N) + 1 \quad (3)$$

$$\text{Variance}: \sigma^2_R = [2N_1N_2(2N_1N_2 - N)]/[(N)^2(N-1)] \quad (4)$$

Analysis and Results

The results of descriptive statistics: means, standard deviation, skewness, and kurtosis of the daily stock returns of time series data in the weak form market during the period under consideration is presented in Table 1. It is observed that the expected return, that is, the mean value of Adani Enterprises Ltd. is .0048678948, which is the highest among all the stocks followed by Hindalco Industries Ltd. and Amber Enterprises India Ltd., with mean value .0048678948 and .0038429766, respectively. Dixon Technologies (India) Ltd. has the lowest average return of –.000435444 followed by Bata India Ltd. with a mean value of .0000413183. From the viewpoint of average return volatility, the study finds that the daily stock return of APL Apollo Tubes Ltd. is most volatile with an *SD* value of .1047770775, and Dixon Technologies (India) Ltd. has been the next most volatile with an *SD* value .1029118072. On the other hand, Dabur India Ltd. is the least volatile stock return with an *SD* value of .0130009491108.

In the case of the symmetrical distribution pattern of the daily returns, GAIL (India) Ltd. is most symmetrical closer to 0 with the coefficients of skewness value .024 that is followed by Alkem Laboratories Ltd. with –.019. As far as the flatness or peakedness of the data order is concerned, the coefficients of kurtosis of most stock returns are within the range of 3, with the exception of a few cases which are above the statistical norms set. The J – B normality test was conducted to examine the results of the normality of the data series.

The results of this normality test display that the p-value in all the stock returns is less than 0.05 at the 5% significance level except for Godrej Consumer Products Ltd. and Hindalco Industries Ltd. as is presented in Table 2. The small *p*-value of the stocks means that these statistically violate the assumption of normal distribution of the data series, and hence, are non-normal data. While in the case of the other two stocks, the *p*-value is more than the statistical norms of 0.05. As a result, these stocks follow the assumption of normality in the distribution of data series; hence, are normal statistically.

Among the various criteria of the weak-form efficient market, one of the essential criteria is that the data series

should follow a random walk. The non-parametric runs test was conducted to examine whether the stock returns follow a random walk or not. The randomness test indicates that all the calculated value in stock returns is less than the *z* critical value of +/–1.96 except for Dixon Technologies (India) Ltd., Adani Total Gas Ltd., and Hindalco

Table 2. ***Jarque – Bera Normality Test of Daily Stock Returns***

Stock No.	Mean	*SD*	Skewness	Kurtosis	Jarque – Bera		
					Score	*p*-value*	Pass
1	.000385880585	.0132944149716	–.293	2.755	77.49	0.0	F#
2	.000497735743	.0133930640516	.765	3.390	136.28	0.0	F#
3	.000708738407	.0130009491108	.291	.728	8.37	1.5	F#
4	.003786786835	.0251221120767	1.868	9.865	1103.47	0.0	F#
5	.001910217792	.0201297321153	3.707	35.479	1.45	48.5	T^
6	.0038429766	.0305622950	1.000	3.217	141.97	0.0	F#
7	.0000413183	.0170599453	.084	1.034	10.40	0.6	F#
8	.0022495839	.0219815990	.864	2.895	112.23	0.0	F#
9	.0022677239	.0224502250	.409	.456	8.68	1.3	F#
10	–.000435444	.1029118072	–14.049	212.877	457640.17	0.0	F#
11	.0013618178	.0185523183	–.259	1.421	22.07	0.0	F#
12	.0035404363	.0316117147	.594	2.062	55.58	0.0	F#
13	.0015118209	.0178492515	.348	4.929	243.66	0.0	F#
14	.0028578659	.0203231221	–.462	3.583	134.36	0.0	F#
15	.0036754160	.0297838314	1.021	2.402	98.65	0.0	F#
16	.0026122065	.0294421491	–.063	2.133	49.24	0.0	F#
17	.0027698322	.0285918678	.361	1.534	27.93	0.0	F#
18	.0026710848	.0405305709	.404	.743	11.77	0.3	F#
19	.0007832180	.0172378552	–.019	1.823	32.12	0.0	F#
20	.0017144980	.0214059931	.253	1.378	20.78	0.0	F#
21	.0006446558	.0210140123	–.305	4.432	196.57	0.0	F#
22	.0026879399	.0206818541	.446	1.732	37.03	0.0	F#
23	.0018333688	.0196352392	.573	2.182	59.58	0.0	F#
24	.0100943021	.0379444511	1.038	3.921	194.68	0.0	F#
25	.0013907234	.0243775302	.216	3.344	111.28	0.0	F#
26	.0003742703	.0173965543	.120	2.220	48.42	0.0	F#
27	.0025390962	.0233234397	.024	.870	7.12	2.8	F#
28	.0031011176	.0232977697	1.098	4.361	235.86	0.0	F#
29	.0000067842	.1047770775	–14.158	215.114	467265.48	0.0	F#
30	.0089113788	.0317634423	1.269	7.433	610.34	0.0	F#
31	.0006824508	.0210982596	.386	1.464	26.65	0.0	F#
32	.0048678948	.0276868579	.142	.056	0.83	66.0	T^
33	.0020094440	.0287411223	.441	1.671	34.84	0.0	F#

Note. Calculated with the help of Numxl.

* indicates percentage; #F stands for false; ^ T stands for true.

Industries Ltd., shown in Table 3. The calculated value falls within the critical value of +/– 1.96, that is, all the data come from a random walk. But in the case of the other three, the calculated value is more than the *z* critical value; hence, these data do not follow the random walk.

Table 3. ***Results of Runs Test of Select Individual Company Stocks***

Stock No.	No. of Runs	*Z* - value	Asymp. Sig. (2 - tailed)
1	118	–.856	.392
2	123	–.245	.806
3	124	–.118	.906
4	120	–.441	.659
5	114	–1.324	.186
6	125	.267	.789
7	125	.016	.987
8	115	–.844	.398
9	119	–.701	.483
10	99	–2.534	.011
11	128	.383	.702
12	131	.802	.422
13	133	1.028	.304
14	124	–.062	.951
15	124	.047	.963
16	129	.547	.584
17	125	.204	.839
18	123	–.108	.914
19	125	.000	1.000
20	122	–.317	.751
21	126	.137	.891
22	122	–.346	.730
23	133	1.235	.217
24	101	–2.469	.014
25	137	1.568	.117
26	110	–1.909	.056
27	125	.084	.933
28	111	–1.574	.116
29	113	–1.220	.222
30	107	–1.931	.054
31	111	–1.778	.075
32	151	3.370	.001
33	120	–.537	.591

Note : Calculated with the help of SPSS 23.

Discussion

In the present study, the first null hypothesis framed is that select companies' daily equity stock returns are normally distributed. The null hypothesis is rejected, which leads to the acceptance of the alternative hypothesis in respect of 31 daily stock returns. Hence, it can be said that the data of these daily stock returns are not normally distributed. This finding is in line with the findings obtained by Moustafa (2004), Fawson et al. (1996), Al-Jafari and Altaee (2011), and Sharma (2013), while the null hypothesis is accepted in respect of two daily stock returns. Hence, the distribution of the data series is normal in these cases. This finding is consistent with the results obtained by Banerjee and Mulligan (2010).

The second null hypothesis framed is that the distribution of daily stock returns of select companies follows a random walk. The null hypothesis is accepted, leading to the rejection of the alternative hypothesis regarding 30 daily stock returns. Hence, it can be said that the distribution of daily stock returns of these select companies follows a random walk and is a weak-form efficient market hypothesis. This finding is consistent with the findings of Moustafa (2004) and Fawson et al. (1996), while the null hypothesis is rejected in the case of three daily stock returns ; hence, the distribution of data series is non-random and is weak-form inefficient market hypothesis in these cases. This finding is similar to that of Al-Jafari and Altaee (2011).

Conclusion and Policy Implications

It is observed that Adani Enterprises Ltd. has the highest average return, but Dixon Technologies (India) Ltd. has the lowest average return among all stock returns during the period. The calculation of SD reveals that APL Apollo Tubes Ltd.'s daily stock return is the most volatile, while Dabur India Ltd. has the least volatile stock return. The coefficients of skewness of GAIL (India) Ltd. have the most symmetry in the distribution pattern of the daily returns, and the coefficients of kurtosis of most stock returns fall within the range of norms of the normal curve. The normality test finds that the data of 31 equity stock prices is not normally distributed except for the two stock prices. Further, the runs test finds that the distribution of daily stock returns of 30 select companies follows a random walk and is the weak-form efficient market. Therefore, an investor cannot anticipate earning abnormal gains in these sectors. But the three stock prices fail to follow a random walk and are inefficient in their weak form, and hence, they are predictable. The study recommends that Adani Enterprises Ltd. followed by Hindalco Industries Ltd. and Amber Enterprises India Ltd. are the investors' first choice based on expected stock returns. The risk-averse investor should give the least preference to APL Apollo Tubes Ltd. and the highest preference to Dabur India Ltd. while deciding on the investment of securities. The stock regulator should observe the average return volatility pattern, market efficiency for formulating a new policy to be adopted in the coming days in the interest of the investors on the one hand, and the growth of the economy on the other hand.

Research Implications

The present study provides insights into the 33 stocks in seven sectors of the different industries for carrying on intra-day trading to those who wish to invest in this sector from the investors' perspectives. The empirical findings will also be helpful to policymakers to design further strategies regarding market efficiency to attract prospective investors in the coming days.

Limitations of the Study and Scope for Further Research

The present study has its own limitations. From the perspective of the sample size, an investigation of a few individual stocks has been made only out of the total stock population in the NSE. The study period of daily

returns is limited to one year only. The main focus on non-parametric *Z* test and J-B test only is another limitation of the current study. The scope of this study can be extended further to contribute more to the existing literature. Studies can be undertaken further on the daily stock returns of some select stocks belonging to all sectors in the NSE during last year. Moreover, a comparative study can be conducted on the daily closing price of select stocks of one sector in the capital market before and after one year of the pandemic using other statistical tests. Further, an empirical investigation can also be made on the closing price of select stocks of particular sectors with a higher net worth in a few capital markets using different statistical tests.

Author's Contribution

Dr. Satya Ranjan Doley conceived the idea and also did the analysis and interpretation of quantitative data collected from the source for the present study.

Conflict of Interest

The author certifies that he has no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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