Testing of Weak Market Efficiency in Indian Stock Market: An Empirical Study of Pharmaceutical Sector

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Abstract:

Market efficiency concept is one of the vital interest areas for economists and researchers around the world. Pharmaceutical sector has seen quite a growth in recent past, as government around the world have made healthcare a priority sector. The target of the study is to examine whether the Indian financial market, with particular reference to the pharmaceutical sector, may be considered to be following a random walk. This study is centered on past price data of two indices and eight pharmaceutical companies' stocks listed on national stock exchange for ten years. Analytical tools namely run test, unit root test and autocorrelation test have been utilized. Though results of tests are varying, we may conclude that the stock market in pharmaceutical sector lacks weak form of efficiency as the return series is neither stationary nor random.

Keywords: Efficient Market Hypothesis, Stationarity Test, Random Walk, Indian Stock Market, Pharmaceutical Sector.

1. Introduction

Investors perceive the stock market as a lucrative place for making quick returns. Most avid stock market investors depend on some logical technique for their stock selection rather than basing their decision solely on their guts. Many also take professionals' assistance to increase their chances of higher returns. Technical and fundamental analysis are two significant ways investors or stock managers use to assess a company's stock. Technical theorists base their judgment on past patterns and believe that history repeats itself. On the other hand, fundamental analysts work on the assumption of intrinsic value, which is influenced by the company's performance and other external factors. Finding the intrinsic value of a stock

and comparing it to the movement of the actual price is their path to gaining returns.

Random walk theory (Fama,1965) propagates the idea that in an efficient financial market security value movement can't be used to predict the future, and actual price and intrinsic value are the same for a stock. Thus, making technical and fundamental analysis futile for predicting future returns. Levy (1967) initiated the idea of classification of market on the basis of efficiency in two forms: weak and strong. Later this categorization was increased to three: strong, semi-string and weak form of market efficiency (Fama,1971).

Random walk model testing for stock market can be attained through different ways, such as empirical testing or technical analysis. Technical analysis id usually preferred if the period of study is short. This paper is empirical in nature.

2. Literature Review

Market efficiency has been a topic of interest for past many decades. In this section we are reviewing some of the relevant studies done beyond Indian stock market. **Bachelier and Cootner (1964)** states in their study that an inefficient market becomes a source of infinite gains for the investors. **Moore (1964)** in his paper, one the earliest, found that studying past weekly price data is futile for earning a gain in stock market. His study included thirty randomly selected stock price numbers for the years 1951 to 1958. **Sharma and Kennedy (1977)** in their work did a comparative stock behavior analysis for three stock exchanges, i.e., Bombay stock exchange, London stock exchange and New York stock exchange. Results proved that Bombay stock exchange was at par in terms of market efficiency with other two exchanges from developed countries. **Roy (2018)** in his paper, tested the random walk theory by taking into account stock exchanges of five regions, i.e. Britain, the European Union, China, India, and Japan. For his study he tested the closing prices of stock market pointers by using parametric tests and non-parametric test. For assessing market efficiency unit root test was applied. The results showed that most of the indices were weak form inefficient. Though various tests gave differing conclusions.

In Indian context, many researchers have analyzed stock market in India for different kinds efficiency, by taking into account past data of various securities. Few relevant studies are discussed here. **Kalsie (2012)** examined the market efficiency of security prices of thirty-seven companies constituting the nifty 50 index. For this purpose, run test was applied on thirty days daily average price for seven years (2001-2007). The author determined the market as weak form efficient. **Sarkar (2019)** tested the market efficiency of top two exchanges in India (National Stock Exchange and Bombay Stock Exchange). He considered daily returns of nifty 50 and S&P Sensex for four years, i.e.,2014 to 2018. Tools used by him included run test (mean, median and zero as base) and Kolmogorov-Smirnov goodness of fit test. Both these tests indicated that the

weak market efficiency was not present. The unit root tests concluded that the return data was stationary at level, making the series modelling possible. Thus, finalizing the result market inefficiency. **Kumar and Jawa (2017)** covered twenty years (1995-2015) of price data of nifty 50 index in their paper for aiming to test market efficiency and checking the existence calendar effect anomaly. The study infers the presence of Wednesday effect and December effect through application of EGARCH estimation methodology. **Pant and Bishnoi (2001)** used daily and weekly market indices return to test random walk-through variance ratio testing. The results rejected that the market was unpredictable, thus concluding that the investors can gain if they study the past trends. **Jain and Jain (2013)** in their study's findings deduced that the BSE index is efficient. Their study covered twenty years i.e. April 1993 to march 2013, of closing price and applied various parametric and non-parametric tests. **Madhusoodanam (1998)** checked two indices(BSE Sensex index and BSE100 index) and 120 individual securities' price data from January 1987 to December 1995, for mean reverting trend. Results through variance ratio test supported a persistent movement of weekly data, thus rejecting random walk assumption for both indices and104 individual stocks.

Two studies with similar objective and related to pharmaceutical sector are reviewed here. **Kumar et al. (2020)** examines the market efficiency of the pharmaceutical sector in all three stages. For testing weak form, they applied run test by utilizing six years' closing prices of ten pharma companies. The outcomes showed that pharma sector is in weak form of efficiency. **Siddikee and begum (2015)** assessed the efficiency of Dhaka stock exchange with focus on pharmaceutical sector by taking into account security price history of thirteen listed companies. In their paper, they utilized run test, which concluded that the pharma stock prices didn't follow random walk. ADF test, Autocorrelation and Box-Ljung tests indicated the incidence of weak market efficiency.

3. Objective

The study intends to analyze market efficiency (weak form) with special focus on Indian pharmaceutical sector. With this in aim, following are the key objectives:

1. To examine market efficiency of National Stock Exchange through nifty index.
2. To assess weak market efficiency of India pharmaceutical stocks through Nifty pharma index and eight individual stocks.

The hypothesis for above objectives are as follows:

H_{01}: Return series of nifty 50 index and nifty pharma index follows a random walk.

H_{02}: Return series of listed pharmaceutical companies' stocks follow a random walk.

H_{03}: Return series of nifty 50 and nifty pharma are non-stationary.

H_{04}: Return series of listed pharmaceutical companies' stocks are non-stationary.

4. Methodology

4.1. Research design

The present work looks into the weak market efficiency in context to Indian stock exchange, focusing on the pharmaceutical sector. We have chosen two indices, Nifty 50 and Nifty Pharma Index for comprehensive market study and eight listed pharmaceutical companies' stocks for individual study. The listed companies selected are constituents of Nifty Pharma Index, which captures the performance of pharmaceutical stocks. Our aim was to study top ten constituent companies (by weightage) of Nifty Pharma Index from 1st January, 2013- 1st January 2023, but data for two companies named Alkem Laboratories Ltd. and Laurus Labs Ltd. was not available according to our study time frame. We have focused on daily compounding returns or log returns for testing the efficiency, which we have calculated through price series as follows (Kalsie and Kalra).

$$r \cong \log(1 + R_t) = \log \frac{P_t}{P_{t-1}} \quad \text{(Eq.1)}$$

The Details regarding the sample indices and stocks are given below in Table 1.

S.No.	Name of indices	Name of listed pharmaceutical companies
1.	Nifty 50 Index	Sun Pharmaceutical Industries Ltd.
2.	Nifty Pharma Index	Dr. Reddy's Laboratories Ltd.
3.		Cipla Ltd.
4.		Divi's Laboratories Ltd.
5.		Aurobindo Pharma Ltd.
6.		Lupin Ltd.
7.		Torrent Pharmaceuticals Ltd.
8.		Zydus Lifesciences Ltd.

4.2. Data collection

We have utilized secondary data for our study. We have collected the historical price data from national stock exchange website and Yahoo Finance website. Other needed information was sourced through various books and journals.

4.3. Analytical tools

A) *Run test*

Run test which is widely applied parametric measure to examine the unpredictability in series. It is one of the oldest tools for testing market efficiency. Run test observes past return data to check the succeeding returns for independence. In this test the positive returns and negative returns are denoted by 'n_1' and 'n_2' respectively and total number of runs are 'n', where total runs should be sum of n_1 and n_2. Z-value of run test tested at 5% significance level.

$$Z = \frac{r - \mu(\mathbf{r})}{\sigma_r} \qquad \text{(Eq.2)}$$

Where, $\mu(\mathrm{r}) = 2 \times \boldsymbol{n_0 x n_{1/n}}$

$$\sigma_r = \sqrt{\frac{2Xn_0Xn_1X(2Xn_0Xn_1 - n)}{n^2(n-1)}} \qquad \text{(Eq.3)}$$

$\mu(\mathrm{r}) = expected\ number\ of\ returns$

$\boldsymbol{\sigma_r} = standard\ deviation\ of\ returns$

B) *Unit root test*

Unit root test has been used quite frequently for checking market efficiency, especially as a combination with Run test. **Hassan, Shoaib and Shah (2007)** have stated that series which do not follow random walk are stationary time series. Stationary series can be easily modelled, through which future prediction about market can be made. Thus, Stationarity in a series indicate that the market is inefficient. In our study, we have used two tests for checking unit root, i.e., Philips Perron test and Augmented Dickey-fuller test at level.

C) *Autocorrelation*

Autocorrelation is a trusted statistic for checking a return series for independence. This test identifies occurrence of correlation in data series. Autocorrelation function (ACF) and correlograms (LjungBox statistic) is utilized for 1-10 lags here. If the market is efficient, null hypothesis of 'no autocorrelation' will be accepted.

Equation for finding autocorrelation coefficient (P_k) at lag k is as follows:

$$P_k = \frac{\sum_{t=1}^{n-k} (R_t - \bar{R})(R_{t+k} - \bar{R})}{\sum_{t=1}^{n} (R_t - \bar{R})^2} \qquad \text{(Eq.4)}$$

Here, K denotes lags, R_t shows rate of return and n is overall number of surveys (Ramkumar et.al.). When we plot for lag k, we get correlogram.

5. Findings and Analysis

The descriptive statistics are displayed in table 2 for two indices and eight pharmaceutical companies' securities. Daily compounded return is used in the study. Through the descriptive statistics, we can see that both the indices are negatively skewed whereas four individual securities (Sun Pharma, Cipla, Torrent Pharma and Zydus Lifesciences) show positive skewness. This indicates that for the indices higher negative returns are common whereas for positively skewed securities, higher positive returns happen more. Kurtosis value for all is positive and higher than three, which shows that the distribution is leptokurtic and higher peaked than the normal distribution. Jarque-Bera tests whether the distribution has skewness and kurtosis suitable for a normal distribution. For our distribution, probability value for all the variables is 0.000, thus concluding that daily return series is not normal.

Now, in order to test whether the return series of selected indices and listed stocks for randomness, we have used two tools, Run test and Autocorrelation and Box-Ljung test. Table 3 and 4 presents the outcomes of run test, with mean and median base respectively. With both the bases we have achieved identical results. The null proposition for the test is that the return series is random. If probability value is below

0.05, we reject the null premise. Run test results at 5% significance level, shows that both the indices reject the null hypothesis. Except Cipla, all other individual securities of pharma sector accept the null hypothesis as p-value is above 0.05

Table 5 presents autocorrelation test results for our chosen sample. For all the indices and company stocks probability value is less than 5% ($p<0.05$), thus we can say that the returns do have autocorrelation and are not random. Run test rejects H_{01}, which states that individually the index series follow a casual walk, while autocorrelation test rejects it too. For H_{02}, which pertains to random walk theory being followed by returns of listed pharmaceutical stocks, run test accepts it for all the companies except one and autocorrelation test rejects it entirely. We can notice the results for both the test in case of indices and one company stock (Cipla) is contradictory.

To test the series for stationarity, Philips-Perron and Augmented Dickey-Fuller test is applied. Both these tests have null hypothesis as follows:

H0: Series has a Unit Root.

Through table 6, we can see that for all the return series t-statistic is above the critical value (1% (3.43) ,5% (2.86) and 10% (2.56)). Probability value is less than 0.05 in all the cases. We can discard the null hypothesis. Thus, concluding that yields of both the indices as well as eight individual stocks are stationary and do not have a unit root. With this result we can reject our H_{03} and H_{04} as return series of both the indices and listed stocks of pharmaceutical companies are stationary as they do not have a unit root.

Table 2. Descriptive Statistics

Index/ company	Mean	Median	maximum	minimum	Standard deviation	skewness	kurtosis	Jarque-Bera	
								statistics	probability
Nifty 50	0.000450	0.000672	0.084003	-0.139038	0.010874	-1.231336	20.58469	32513.88	0.000000
Nifty pharma	0.000296	0.000517	0.098650	-0.093507	0.012681	-0.154843	7.739776	2326.642	0.000000
Sun pharma	0.000384	0.000322	0.104469	-0.163202	0.019404	0.366958	8.567133	3238.559	0.000000
Dr. Reddy lab	0.000330	0.000142	0.129870	-0.157366	0.017385	-0.206823	10.66927	6058.640	0.000000
Cipla	0.000353	-0.000493	0.122550	-0.092397	0.016711	0.449757	7.177684	1875.677	0.000000
Divi's lab	0.000726	0.000802	0.149787	-0.251862	0.020016	-1.242132	24.55329	48346.43	0.000000
Aurobin-do pharma	0.000603	0.000000	0.184600	-0.210340	0.025010	-0.132186	12.06679	8450.490	0.000000
Lupin	5.44E-05	0.000130	0.126405	-0.184906	0.018763	-0.211180	10.70775	6120.157	0.000000
Torrent pharma	0.000868	2.78E-05	0.125340	-0.163767	0.018681	0.054876	8.986345	3681.927	0.000000
Zydus lifescienc-es	0.000345	-0.000298	0.180972	-0.159653	0.019935	0.578233	10.77462	6345.538	0.000000

Table 3. Run Test (Mean)

Index/ company	Test Value	Cases < Test Value	Cases >= Test Value	Total Cases	Number of Runs	Z	Asymp. Sig. (2-tailed)
Nifty 50 Index	.000449567292439	1209	1266	2475	1156	-3.293	<.001
Nifty Pharma index	.000295902114384	1220	1255	2475	1128	-4.434	<.001
Sun pharma	.000384132063608	1243	1222	2465	1261	1.112	.266
Dr. Reddy lab	.000330331757248	1252	1213	2465	1214	-.773	.439
Cipla	.000353299460130	1317	1148	2465	1298	2.846	.004
Divi's lab	.000725959456416	1225	1240	2465	1244	.425	.671
Aurobindo pharma	.000602604267198	1272	1193	2465	1239	.273	.785
lupin	.000054360044620	1222	1243	2465	1250	.668	.504
Torrent pharma	.000867778151991	1289	1176	2465	1261	1.215	.224
Zydus lifesciences	.000344755256049	1288	1177	2465	1222	-.363	.716

Table 4. Run Test (Median)

Index/ company	Test Value[a]	Cases < Test Value	Cases >= Test Value	Total Cases	Number of Runs	Z	Asymp. Sig. (2-tailed)
Nifty 50 Index	.000671937669468	1237	1238	2475	1160	-3.156	.002
Nifty Pharma Index	.000516862655259	1237	1238	2475	1132	-4.282	<.001
Sun Pharma	.000322132394367	1232	1233	2465	1263	1.189	.235

Dr. Reddy Lab	.000142498908272	1232	1233	2465	1212	-.866	.386
Cipla	-.000493065467794	1232	1233	2465	1304	2.841	.005
Divi's Lab	.000801796097547	1232	1233	2465	1244	.423	.672
Aurobindo Pharma	.000000000000000	1229	1236	2465	1231	-.100	.920
Lupin	.000130187403595	1232	1233	2465	1246	.504	.615
Torrent Pharma	.000027754353481	1232	1233	2465	1275	1.672	.095
Zydus Lifesciences	-.000297781171372	1232	1233	2465	1224	-.383	.702

Table 5. Autocorrelation Test

Index/company	Lags	1	2	3	4	5	6	7	8	9	10
Nifty 50 index	AC	-0.496	-0.01	0.017	-0.066	0.144	-0.169	0.119	-0.041	-0.025	0.08
	PAC	-0.496	-0.34	-0.236	-0.278	-0.069	-0.211	-0.1	-0.102	-0.121	-0.035
	Q-Stat	609.3	609.55	610.31	621.01	672.66	743.82	779.2	783.29	784.79	800.54
	Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nifty pharma index	AC	-0.499	0.01	-0.011	-0.001	0.022	-0.05	0.044	-0.002	-0.011	-0.008
	PAC	-0.499	-0.318	-0.242	-0.197	-0.13	-0.166	-0.116	-0.081	-0.076	-0.084
	Q-Stat	616.1	616.34	616.64	616.64	617.89	624.12	628.89	628.9	629.22	629.36
	Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sun pharma	AC	-0.499	0.015	-0.038	0.025	0.011	-0.029	0.005	0.034	-0.028	0.007
	PAC	-0.499	-0.311	-0.27	-0.207	-0.146	-0.154	-0.148	-0.083	-0.084	-0.07
	Q-Stat	613.88	614.47	618.03	619.58	619.88	621.9	621.96	624.85	626.73	626.87
	Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Dr. Reddy lab	AC	-0.466	-0.042	0.018	-0.009	0.016	-0.033	0.02	0.006	-0.012	-0.023
	PAC	-0.466	-0.332	-0.235	-0.193	-0.135	-0.15	-0.122	-0.096	-0.094	-0.131
	Q-Stat	536.39	540.84	541.63	541.83	542.49	545.15	546.13	546.2	546.59	547.85
	Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Cipla	AC	-0.524	0.017	0.011	-0.011	0.011	0.018	-0.035	0.012	0.008	-0.017
	PAC	-0.524	-0.355	-0.256	-0.215	-0.17	-0.103	-0.113	-0.105	-0.082	-0.093
	Q-Stat	677.2	677.95	678.24	678.54	678.87	679.67	682.67	683	683.17	683.9
	Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Divi's lab	AC	-0.465	-0.035	0.012	-0.008	-0.022	0.002	0.04	-0.006	-0.041	0.043
	PAC	-0.465	-0.321	-0.226	-0.182	-0.184	-0.179	-0.111	-0.076	-0.116	-0.068
	Q-Stat	533.44	536.46	536.82	536.99	538.19	538.2	542.17	542.25	546.41	551.04
	Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Aurobindo pharma	AC	-0.503	-0.002	0.018	-0.009	-0.001	-0.033	0.031	0.028	-0.044	0.024
	PAC	-0.503	-0.342	-0.236	-0.186	-0.154	-0.188	-0.161	-0.09	-0.111	-0.087
	Q-Stat	624.53	624.54	625.3	625.51	625.51	628.23	630.67	632.55	637.34	638.79
	Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Lupin	AC	-0.491	-0.01	0.001	0.018	-0.026	0.013	-0.002	-0.028	0.024	0.012
	PAC	-0.491	-0.332	-0.249	-0.171	-0.161	-0.129	-0.109	-0.142	-0.124	-0.091
	Q-Stat	594.82	595.08	595.09	595.92	597.6	598.03	598.04	600.04	601.45	601.81
	Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Torrent pharma	AC	-0.471	-0.031	-0.012	0.024	-0.004	-0.019	0.011	-0.014	0.025	-0.015
	PAC	-0.471	-0.324	-0.264	-0.191	-0.152	-0.153	-0.132	-0.143	-0.108	-0.109
	Q-Stat	545.93	548.25	548.62	550.02	550.05	550.91	551.18	551.64	553.18	553.77
	Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Zydus life sciences	AC	-0.478	-0.035	0.02	-0.003	0.01	-0.031	0.03	-0.025	-0.006	0.022
	PAC	-0.478	-0.342	-0.244	-0.191	-0.138	-0.152	-0.107	-0.119	-0.135	-0.111
	Q-Stat	563.51	566.61	567.64	567.66	567.89	570.22	572.51	574.03	574.14	575.35
	Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 6. Unit Root Test

Index/company	ADF Test		PP Test	
	t-stats	Prob.	Adjacent t-Stat	Prob.
Nifty 50	-17.63921	0.0000	-49.59722	0.0001
Nifty pharma	-47.85560	0.0001	-47.99063	0.0001
Sun pharma	-49.29714	0.0001	-49.29614	0.0001
Dr. reddy lab	-46.45022	0.0001	-46.44631	0.0001
cipla	-51.79425	0.0001	-51.74667	0.0001
Divi's lab	-46.78676	0.0001	-46.72458	0.0001
Aurobindo pharma	-50.10776	0.0001	-50.10505	0.0001
lupin	-48.31798	0.0001	-48.32872	0.0001
Torrent pharma	-48.54725	0.0001	-48.91945	0.0001
Zydus lifesciences	-48.49390	0.0001	-48.52241	0.0001

6. Conclusion

The empirical findings in our paper is contrasting, depending on the different analytical tools used. Presence of random walk is rejected altogether for both the indices. Also, the return series of both, market index and pharma index are stationary which indicates towards inefficiency. This is because stationary series can be modelled, thus allowing the investors opportunity to make supernormal gains. Therefore, we can agree that both the indices are not efficient (in weak form). The finding is supported by similar studies done by Kalsie & Kalra (2015) and Sarkar(2019).

In case of individual stocks, presence of stationarity is accepted for all the companies, which is evidence of inefficient market. Run test and autocorrelation test give differing results for seven company stocks. As two tests suggests weak form inefficiency, we may conclude that daily stock returns of pharmaceutical companies can be utilized by prospective investors to know the trend. Lack of weak form of efficiency imply that security price is not reflecting all the past information. Further study in similar context can be conducted to know various causes of inefficiency in Indian pharmaceutical stock market. These may involve lots of factors such as economic, political, environmental etc., which can be explored more.

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