Orissa Journal of Commerce
Vol. 43, Issue 3, July-September 2022
ISSN: 0974-8482

URL: www.ojcoca.org
DOI: https://doi.org/10.54063/ojc.2022.v43i03.12

Analysis of Randomness in the Pharmaceutical Sector of Indian Stock Market: Pre- and During Covid-19 Period

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To cite this paper

Chavarkar, S.S., & Nayak, K.K.M. (2022). Analysis of Randomness in the Pharmaceutical Sector from Indian Stock Market: Pre-and During Covid-19 Period. *Orissa Journal of Commerce*. 43(3), 160-175.

Keywords

Random walk, Efficient market, Pharmaceutical sector, Runs test, ADF test

JEL Classification

G01, G14, G17, G41, E44

Abstract: This paper examines the behavior of stock prices outperforming pharmaceutical industries of India during the Covid-19 pandemic period. The top 10 pharmaceutical companies listed in the National Stock Exchange were selected for the present study. The study is divided into two periods I. Pre-pandemic period (1st April 2019 to 19th Feb 2020) and II. During the pandemic period (20th Feb. 2020 to 31st Dec 2021). The analysis by a series of tests viz. ADF unit root test, variance ratio test and runs test indicate the randomness in the time-series data. The results also suggest the weak-form efficiency of the Indian pharmaceutical industry during the selected period. The present investigation will serve as a precursor for an extended study on stock pricing analysis as well as provide a guideline to all stakeholders, portfolio managers, and market participants to gauge the randomness of the stock market as well as the role of technical analysis.

1. Introduction

The Efficient Market Hypothesis (EMH) is a happening topic that many financial experts and stock market analysts have been eager to develop and examine the modes of stocks' current price behavior and their future price movement and predictions. As per the term Efficient Market Hypothesis (EMH) as defined by its creator (Fama, 1970) the stock market is to be considered efficient if its stock prices are followed wholly by all available information. When any news or information arrives and spreads rapidly, its effect on the stock prices, whether positive or negative, is almost immediate. For obvious reasons, the time of incidence or appearance of such information or news cannot be predicted and as it affects the stock prices, new stock prices are different from older stock prices. This makes them random in nature (Bodie *et al.*, 2008). The efficiency of the market depends completely on how, when, and to what extent information is made available to investors. EMH is based on the informational efficiency of the market. That means all investors know everything about the market and they act

rationally. It is a good example of weak form efficiency. This weak form is qualitatively similar to the random walk activity, which states that old market rates of stocks are not able to provide information in predicting future prices of stocks thus a study of technical analysis with the help of charts, graphs, different tools, that is also based on old trends of the stock prices is not useful for the investors for prediction purposes. It is assumed that in an efficient market, there would be no chance for overvalued and undervalued stocks. The stock market prices and the true value of stocks would not differ. If the market is efficient, then stock prices will behave randomly (Samuelson, 1965) whereas (Hayek, 1945) says that prices of any stock can only move due to news coming into the market and therefore they are unpredictable.

As the Indian capital market has witnessed tremendous development after liberalization (Shaikh, 2013). Since the inception of the National Stock Exchange in 1994, the implementation of several useful ideas such as dematerialization, reduction in the settlement days, screen-based trading system, transparency in the derivatives market as well as improved efficiency and safety of the Indian stock markets has been instrumental in changing the Satta Bazar identity of the Indian stock market to a modern, developed and matured stock market. This has also been extremely useful in reducing insider trading and speculative activities after the infamous Harshad Mehta scam in 1992 (Bill, 2017). It was an eye-opener to the governing body of the Indian stock market, the Securities Exchange Board of India (SEBI) which then had taken many strict measures to make the Indian stock market more efficient.

While Indian stock is improving in its efficiency, the pharmaceutical industry of India has become the third largest industry in the world in 2020 (McKinsey & Co., Report, 2020). India exports to more than 200 countries and India's share in global trade is around 20%. Being an emerging market, the pharmaceutical industry is important for revenue generation and job creation. It is essential to study the randomness of this industry, which is a crucial part of the Indian stock market. The Indian stock market faced volatility twice before the pandemic Covid 2019, due to a reduction in operations in the 1992 Harshad Mehta scam and the 2008 financial crisis. Infection of diseases is not limited to human beings but it affects the health and financial condition of the country (Mayer, 2000). But in the pandemic Covid -19 crisis, though all other sectors were affected badly, the pharmaceutical industry of India has had a positive impact due to high demand from all over the world and factories closed in China due to lockdown (Mittal and Sharma, 2021). The pharmaceutical sector is rapidly growing, as exports have increased to other countries. According to a recent study it is estimated that the Indian pharmaceutical sector supplies more than 50% of the various vaccines demand for the world, more than 40% of the generic pharma demand for the United States, and 25% of various medicines for the United Kingdom. Thus, it is no wonder that India contributes towards the second largest share of the global pharmaceutical and biotech technical workforce. Also, according to the Indian economic survey, the domestic market is expected to grow three times in the next decade. (IBEF Report, March 2022)

During the pandemic period, the demand for medicines, vaccines, and other products has increased rapidly which led to a boom in this sector (Mohapatra, 2020). Indian pharmaceutical companies are in demand in the international market due to investments in research in vaccinations. Table 1 shows 2022 data of the top 10 Indian pharmaceutical companies selected for the study.

Table 1: Turnover of Top 10 Pharmaceutical Companies of India in 2022

S. No	*Name of the Company*	*Annual Turnover (Rs. Crore)*
1	Sun Pharmaceutical Industries Limited (SUNPHARMA.NS)	2,19,407
2	Divi's Laboratories Limited (DIVISLAB.NS)	1,18,290
3	Cipla Limited (CIPLA.NS)	84,711
4	Apollo Hospitals Enterprise Limited (APOLLOHOSP.NS)	68,595
5	Dr. Reddy's Laboratories Limited (DR REDDY.NS)	66,681
6	Piramal Enterprises Limited (PEL.NS)	53,322
7	Torrent Pharmaceuticals Limited (TORNTPHARM.NS)	46,769
8	Alkem Laboratories Limited (ALKEM.NS)	41,864
9	Aurobindo Pharma Limited (AUROPHARMA.NS)	39,797
10	Biocon Limited (BIOCON.NS)	39,608

Source: Authors' Own Compilation

The study is divided into two parts to check the changes occurring in the pharmaceutical industry during the pre-pandemic period and during the pandemic period. And to see if there are any opportunities available for investors to make abnormal gains by investing in this industry during the pandemic period. Also, to analyze whether the stock prices of pharmaceutical companies pursue a random walk activity as expected by the market efficiency.

It is expected that the approach discussed in the present study can be implemented for a detailed investigation of any sector of the stock market during global (natural and political) crises, political decisions such as elections, annual budget releases, etc. In such scenarios, many investors, brokers, academicians, students, as well as the stock market regulatory authorities will be able to gauge the importance and determine advanced applications of the present study.

2. Review of Literature

A review of the notable studies reveals mixed opinions about the efficiency and the behavior of various stock markets. Some notable studies are reviewed in the following sections.

Earlier many researchers supported weak form efficiency in different countries' stock markets with the help of various statistical tests (Chen, 2008) to examine the random walk hypothesis (RWH) of European and North American markets. And to (Chan *et al.*, 1992) examine the weak form efficiency of Hong Kong, Taiwan, Japan, United States, Singapore, and Korean markets. (Worthington and Helen, 2004) studied European Markets RWH. Basically, worldwide testing of the random walk hypothesis is studied by many researchers.

Weak form inefficiency supports profitable trading in the market. Investors can enjoy hefty gains by taking the help of old prices. Random walk theory is an extension of the efficient market hypothesis, which states that a subsequent share price of any stock changes randomly with its former stock prices.

It is assumed that some news or information related to an industry or a company directly affects stock prices every day. In other words, the previous day's information has no news value for the next day. Every day's prices change with the news or information coming in on that day. According to this theory, all stock prices are independent. The current prices of any stocks are not dependent on past prices of them. It means that past rates of stocks do not contain any beneficial information which may help the investors to predict the future rates of these stocks. Many researchers work on the efficiency of weak form, some of them are of the opinion that markets do not have weak form efficiency (Rahman, 2016; Arora, 2013; Kumar and Singh, 2013 with Thomas and Dileep, 2010) while some of them are in favor of weak form efficiency in the market (Belgaumi, 1995; Chavannavar and Patel, 2016; Jain *et al.*, 2013) EMH is one of the popular financial theories that describe the behavior of stock prices on stock exchanges. It states that a series of rates of any stock is always random in nature. Therefore, all methods of forecasting future rates of stocks are pointless due to such unpredictable, unreliable walks of series of prices.

Ahmed (2019) studied Dhaka Stock Exchange's (DSE) two indices and found that DSE is an inefficient market, prices are not randomly behaved and therefore investors fully depend on past prices to predict future prices as real-time information of listed companies is not available. It shows that the Dhaka market is inefficient in nature. Sook and Qaiser (2015) observed in Malaysian financial firms' stock prices series that, for the short run it may be possible to predict the future rates of financial firms on the basis of their past prices but it is not possible in the long run. In Malaysia, the financial sector follows a weak form of efficiency. The rates of these stocks move randomly. Urrutia (1995) proves that emerging Latin American stock exchanges were not following a random walk. It shows that the current prices were not depending on the past prices of the stock which indicated a weak form of efficiency.

Pandey and Mohapatra (2017) studied the Indian capital market for pre and post-sub-prime, whereas after studying the National Stock Exchange and Bombay Stock Exchange's two years stock prices, Sharma (2011) has stated that there is an absence of abnormalities in these markets which shows the Indian stock market's efficiency. Both the markets from an information point of view are efficient, all information in the market is available to the investors freely and equally and therefore manipulative practices are not possible to earn extra abnormal profits by adopting any pattern. All prices of stocks have been already reflected by the old information as well as nearer forecasted information. Nayak (2012) concluded that the Indian stock market is following cent percent a random walk. He further added that in India, the stock market is efficient. The clear information made available to all investors is equal hence cheating in the stock prices of companies in Indian stock exchanges is not possible. Therefore, forecasting future rates of the stock market is not dependent on old rates of the stocks. According to him, the stock markets of India are at a strong level of efficiency, investors have to trade on the basis of trust in the Indian market. He applied a runs test to check the validity of the random walk.

Kushwah *et al.* (2013) also examined the stock markets of India, which follow weak form efficiency. Many changes like modernization, liberalization, globalization, and international level technology make the Indian market more efficient in information. They also added that, in India, due to revolutions in

the stock market and its transparency, now there is no use to follow up technical analysis which is based on the past rates trend. Jain P. and his co-workers (2013) checked the informational efficiency of the Indian stock market covering the recession period. They concluded that BSE indices were inefficient in the pre-recession period but the rest of the four indices were showing that Indian stock markets are efficient in weak form. Mathivannan and Selvakumar (2015) proved that the random walk is followed by the National Stock Exchange and it follows a weak form. That means the size and movement of the next stock price is changing in a random manner.

Whereas some researchers do not agree with the opinion, according to them Indian stock markets have weak form inefficiency and therefore do not follow a random walk. Madhusoodanan (1998) stated that random walk is not followed by the Indian capital market, and the variances in the rates of stocks are not equal. Mishra (2009) studied the Bombay Stock Exchange for testing the completeness of the stock market of India and found that BSE is not an efficient market. Random walk does not exist in this market which indicates the absence of weak form efficiency. Verma Rao (2007) observed the Indian stock market for three years 1998-99, 1999-2000 and 2000-21. He found that in the first two years the Indian market was showing weak form inefficiency while in the last year it was showing weak form efficiency in the market.

According to Thomas and Dileep (2010) in the Global Crisis period 2008, the Indian capital market was showing inefficiency of weak form. It means that from old rates of stocks investors, analysts can easily estimate the future rates of stocks. The market does not follow random walks. They applied Auto correlated tests on the data collected from National Stock Exchange and Bombay Stock Exchanges. Ehsan (2021) on the basis of the monthly return of Renata ltd pharmaceutical company of Bangladesh found weak form efficiency in Dhaka Stock Exchange with the help of the Augmented Dick Fuller (ADF) test and Variance Root Test.

Gupta and Narwal (2022) studied Indian stock market stationarity with the help of the ADF test. Whereas Ume *et al.* (2017) say that in the Pakistan stock market weak form inefficiency exists. Investors can earn hefty profits on the basis of past stock prices. They also used ADF and Runs tests to check the randomness of stock prices. Randomness in stock markets varies from country-to-country and industry-to-industry. We feel it is required to undertake detailed research of important sectors like the pharmaceutical sector which plays an important role in the Indian economy. We have tested Indian pharmaceutical companies by using the same tests to check the randomness of prices in the same industry during the crisis and pre-pandemic periods. The current paper focuses on the pharmaceutical industry of India to check whether stock prices of this industry are behaving randomly or not. Whether there is a pattern involved in the market to make abnormal gains in pandemic conditions? The attempt is to check the randomness of the pharmaceutical industry and its market efficiency during the two periods under study.

3. Objective and Hypothesis of the Study

3.1. Objective of the Study

The main objective of the study is:

- To study the randomness in the Indian pharmaceutical sector during pre-pandemic and during the pandemic Covid- 19.

3.2. Hypothesis of the Study

The hypothesis has been established to achieve the above objectives.

H_{01}: The pharmaceutical sector of India follows Random Walk.

4. Research Methodology

The purpose of this study is to observe the random walk of the pharmaceutical sector of India. Therefore, the research design is descriptive in nature. The study is divided into two periods I. Pre-pandemic (1st April 2019 to 19th March 2020) and II. During the pandemic (20th February 2020 to 31st December 2021) taking daily adjusted closing price data of ten top pharmaceutical companies of India, listed in NSE available on finance.yahoo.com website. The study is based on the pharmaceutical companies in India only. The study has adopted both parametric (Augmented Dicky- Fuller - unit root, Variance ratio) and non-parametric (Runs) test to check the weak form efficiency of the Indian pharmaceutical industry in selected periods. The values are calculated with the help of SPSS 25 and E-Views software.

5. Results and Discussions

5.1. Descriptive Statistics

The descriptive statistics of daily returns of Indian pharmaceutical companies for pre-pandemic period and during the pandemic period are depicted in table 2 and table 3 respectively.

5.1.1. Descriptive Statistics of Daily Returns of Selected Companies in Pre-Pandemic Period

Table 2 shows descriptive statistics of selected companies during the pre-pandemic period. Out of all selected pharmaceutical companies except SUNPHARMA.NS, CIPLA.NS, PEL.NS,

Table 2: Descriptive Statistics of Daily Returns in Pre-Pandemic Period

Sr. No.	*Name of the company*	*Mean*	*Std. Deviation*	*Skewness*	*Kurtosis*	*Min.*	*Max.*
1	SUNPHARMA.NS	-0.0005	0.0188	-0.0822	2.7368	-0.0906	0.0566
2	DIVISLAB.NS	0.0013	0.0161	-1.4296	9.3097	-0.0975	0.0551
3	CIPLA.NS	-0.0006	0.0147	0.2782	0.4697	-0.0369	0.0455
4	APOLLOHOSP.NS	0.0017	0.0188	1.0094	4.2276	-0.0645	0.0957
5	DRREDDY.NS	0.0009	0.0141	0.2069	2.0373	-0.0567	0.0519
6	PEL.NS	-0.0018	0.0306	-0.2163	1.7571	-0.1339	0.0795
7	TORNTPHARM.NS	0.0009	0.0171	1.0501	4.4600	-0.0546	0.0948
8	ALKEM.NS	0.0020	0.0145	0.5681	0.9480	-0.0333	0.0506
9	AUROPHARMA.NS	-0.0008	0.0287	0.2659	19.5848	-0.1897	0.2027
10	BIOCON	0.0002	0.0198	-0.3254	2.2024	-0.0865	0.0705

Source: Authors' Own Compilation

AUROPHARMA.NS have positive returns ranging from BIOCON (0.02%) to ALKEM (0.20%). The standard deviation ranges DRREDDY.NS (1.41%) to PEL.NS (3.06%). All return series are positively skewed except SUNPHARMA.NS, DIVISLAB.NS, PEL.NS, and BIOCON. In the case of AUROPHARMA.NS (19.58) kurtosis value is high compared to others.

5.1.2. Descriptive Statistics of Daily Returns of Selected Companies During Pandemic Period

Table 3 shows descriptive statistics of selected companies during the pandemic period. All selected pharmaceutical companies have positive returns ranging from BIOCON (0.06%) to APOLLOHOSP.NS (0.26%). The standard deviation is ranging from PEL.NS (1.88%) to AUROPHARMA.NS (2.97%). All return series are positively skewed. In the case of AUROPHARMA.NS (11.49) kurtosis value is high compared to others.

Table 3: Descriptive Statistics of Daily Returns during Pandemic Period

Sr. No	*Name of the company*	*Mean*	*Std. Deviation*	*Skewness*	*Kurtosis*	*Min.*	*Max.*
1	SUNPHARMA.NS	0.0018	0.0211	0.4343	5.1781	-0.1116	0.1101
2	DIVISLAB.NS	0.0019	0.0206	0.3241	5.3231	-0.1100	0.1196
3	CIPLA.NS	0.0019	0.0213	1.2026	5.2493	-0.0685	0.1304
4	APOLLOHOSP.NS	0.0026	0.0278	0.5485	6.5982	-0.1499	0.1549
5	DRREDDY.NS	0.0011	0.0197	1.1205	9.6143	-0.1049	0.1387
6	PEL.NS	0.0017	0.0188	1.0094	4.2276	-0.0645	0.0957
7	TORNTPHARM.NS	0.0011	0.0210	0.5674	5.4236	-0.0790	0.1335
8	ALKEM.NS	0.0009	0.0193	1.1441	9.5838	-0.0789	0.1494
9	AUROPHARMA.NS	0.0009	0.0297	0.1407	11.4919	-0.1681	0.1912
10	BIOCON	0.0006	0.0222	0.1471	3.3877	-0.1091	0.0940

Source: Authors' Own Compilation

5.2. Parametric Test

5.2.1. Augmented Dickey-Fuller (ADF) Unit Root Test

The ADF unit root test is used in order to check stationarity in the return series of selected companies for both periods and the results are depicted in Table 4 and Table 5.

5.2.1.1. ADF Unit Root Test of Selected Companies for Pre-Pandemic Period

Table 4 shows that for all 10 companies, t-statistic values are lesser than critical values at the 1% level, which rejects the null hypothesis that the time series has a unit root. It means that the time series of all companies are stationary at a level without a unit root.

Null Hypothesis: Series has a unit root.

Exogenous: None

Lag Length: 0 (Automatic - based on SIC, maxlag=14)

Table 4: Augmented Dickey-Fuller (ADF) Unit Root Test for Pre-Pandemic Period

Sr. No.	*Name of the company*	*Coefficient*	*Std. Error*	*t- Statistic*	*Prob.**
1	SUNPHARMA.NS	-1.1492	0.0672	-17.1047	0
2	DIVISLAB.NS	-1.2175	0.0663	-18.3623	0
3	CIPLA.NS	-1.1411	0.0679	-16.8186	0
4	APOLLOHOSP.NS	-1.0251	0.068	-15.0813	0
5	DRREDDY.NS	-1.0715	0.0679	-15.7756	0
6	PEL.NS	-0.9879	0.0682	-14.4941	0
7	TORNTPHARM.NS	-1.0337	0.0695	-14.8815	0
8	ALKEM.NS	-1.0879	0.0678	-16.0572	0
9	AUROPHARMA.NS	-1.0694	0.0774	-13.8194	0
10	BIOCON	-1.0687	0.068	-15.7179	0

Test critical values: 1% level - 2.575662

5% level -1.942296

10% level -1.615725

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

All values are significant at a 1% level of significance.

Source: Authors' Own Compilation

5.2.1.2. ADF-Unit Root Test of Selected Companies During Pandemic Period

Table 5 shows that all 10 companies t – statistical values are lesser than critical values at the 1% level, which rejects the null hypothesis that the time series has a unit root. It means that the time series of all companies are stationary at a level without a unit root.

Null Hypothesis: Series has a unit root.

Exogenous: None

Lag Length: 0 (Automatic - based on SIC, maxlag=14)

5.2.2. Multiple Variance Ratio Test

In order to check homoscedasticity and heteroscedasticity in the return series of selected companies, the Multiple Variance test is used for pre-pandemic and during pandemic periods and the results are depicted in Table 6 and Table 7 respectively. The randomness of daily returns of selected companies is examined by using a variance ratio test with the help of 2, 4, 8, and 16 lags in both periods.

Table 5: Augmented Dickey-Fuller (ADF) Unit Root Test during Pandemic Period

Sr. No.	*Name of the company*	*Coefficient*	*Std. Error*	*t- Statistic*	*Prob.**
1	SUNPHARMA.NS	-1.0516	0.0465	-22.5909	0.0000
2	DIVISLAB.NS	-1.0381	0.0466	-22.2755	0.0000
3	CIPLA.NS	-1.0097	0.0466	-21.6589	0.0000
4	APOLLOHOSP.NS	-1.0553	0.0466	-22.6663	0.0000
5	DRREDDY.NS	-0.9725	0.0465	-20.8990	0.0000
6	PEL.NS	-0.9725	0.0465	-20.8990	0.0000
7	TORNTPHARM.NS	-0.9508	0.0465	-20.4257	0.0000
8	ALKEM.NS	-1.1042	0.0660	-16.7292	0.0000
9	AUROPHARMA.NS	-1.0280	0.0451	-22.7769	0.0000
10	BIOCON	-1.0480	0.0466	-22.4998	0.0000

Test critical values: 1% level - 2.575662

5% level -1.942296

10% level -1.615725

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

All values are significant at 1% level of significance.

Source: Authors' Own Compilation

5.2.2.1. Multiple Variance Ratio Test of Selected Companies for Pre-Pandemic Period

Table 6 shows that the null hypothesis of homoscedasticity is rejected as the p-value of selected companies is less than 5% significance level and accepts heteroscedasticity in the series.

Table 6: Multiple Variance Ratio Test in Pre- Pandemic Period

Sr. No.	*Name of the company*	*Lags (q)*	*VR(q)*	*Z Statistic*	*Probability value*
1	SUNPHARMA.NS	2	0.4417	-4.6461	0.0000
		4	0.2002	-4.0791	0.0000
		8	0.1030	-3.4399	0.0006
		16	0.0620	-2.6819	0.0073
2	DIVISLAB.NS	2	0.3985	-4.2976	0.0000
		4	0.2391	-3.3865	0.0007
		8	0.1024	-3.0484	0.0023
		16	0.0523	-2.5567	0.0106
3	CIPLA.NS	2	0.4298	-5.8682	0.0000
		4	0.2163	-4.6861	0.0000

contd. table 6

Sr. No.	*Name of the company*	*Lags (q)*	*VR(q)*	*Z Statistic*	*Probability value*
		8	0.1256	-3.6522	0.0003
		16	0.0631	-2.8093	0.0050
4	APOLLOHOSP.NS	2	0.5160	-4.9781	0.0000
		4	0.2506	-4.4895	0.0000
		8	0.1307	-3.6227	0.0003
		16	0.0700	-2.8198	0.0048
5	DRREDDY.NS	2	0.4758	-5.4673	0.0000
		4	0.2434	-4.8041	0.0000
		8	0.1140	-4.0716	0.0000
		16	0.0700	-3.0063	0.0026
6	PEL.NS	2	0.4682	-5.7852	0.0000
		4	0.2469	-4.6457	0.0000
		8	0.1342	-3.6174	0.0003
		16	0.0616	-2.8278	0.0047
7	TORNTPHARM.NS	2	0.5098	-4.5494	0.0000
		4	0.2382	-4.2553	0.0000
		8	0.1227	-3.4478	0.0006
		16	0.0660	-2.7092	0.0067
8	ALKEM.NS	2	0.4125	-5.2922	0.0000
		4	0.2164	-4.1435	0.0000
		8	0.1330	-3.3032	0.0010
		16	0.0600	-2.6634	0.0077
9	AUROPHARMA.NS	2	0.4863	-3.7850	0.0002
		4	0.2697	-3.3819	0.0007
		8	0.1264	-2.9977	0.0027
		16	0.0787	-2.4933	0.0127
10	BIOCON	2	0.4666	-5.1253	0.0000
		4	0.2445	-4.3018	0.0000
		8	0.1277	-3.5449	0.0004
		16	0.0584	-2.7928	0.0052

Source: Authors' Own Compilation

5.2.2.2. Multiple Variance Ratio Test of Selected Companies During Pandemic Period

Table 7 shows that the null hypothesis of homoscedasticity is rejected as the p-value of selected companies is less than a 5% significance level and accepts heteroscedasticity in the series during the pandemic period.

Table 7: Multiple Variance Ratio Test during Pandemic Period

Sr. No.	*Name of the company*	*Lags (q)*	*VR(q)*	*Z Statistic*	*Probability value*
1	SUNPHARMA.NS	2	0.4507	-6.2467	0.0000
		4	0.2207	-5.3601	0.0000
		8	0.1162	-4.3801	0.0000
		16	0.0652	-3.1791	0.0015
2	DIVISLAB.NS	2	0.4655	-6.2457	0.0000
		4	0.2374	-5.2914	0.0000
		8	0.1210	-4.3364	0.0000
		16	0.0605	-3.3231	0.0009
3	CIPLA.NS	2	0.4781	-6.1483	0.0000
		4	0.2466	-5.2854	0.0000
		8	0.1209	-4.3371	0.0000
		16	0.0616	-3.3876	0.0007
4	APOLLOHOSP.NS	2	0.4484	-4.3311	0.0000
		4	0.2450	-3.6690	0.0002
		8	0.1210	-3.3061	0.0009
		16	0.0652	-2.7647	0.0057
5	DRREDDY.NS	2	0.5091	-5.1539	0.0000
		4	0.2476	-4.8631	0.0000
		8	0.1220	-4.2980	0.0000
		16	0.0684	-3.3565	0.0008
6	PEL.NS	2	0.4947	-6.9153	0.0000
		4	0.2681	-5.6825	0.0000
		8	0.1370	-4.5925	0.0000
		16	0.0634	-3.5822	0.0003
7	TORNTPHARM.NS	2	0.5047	-6.7980	0.0000
		4	0.2638	-5.7426	0.0000
		8	0.1423	-4.5234	0.0000
		16	0.0673	-3.5157	0.0004
8	ALKEM.NS	2	0.5451	-5.0827	0.0000
		4	0.2516	-5.1130	0.0000
		8	0.1245	-4.2770	0.0000
		16	0.0639	-3.2991	0.0010
9	AUROPHARMA.NS	2	0.4541	-4.8512	0.0000
		4	0.2483	-4.0376	0.0001
		8	0.1067	-3.3514	0.0008
		16	0.0585	-2.3989	0.0164
10	BIOCON	2	0.4592	-6.3680	0.0000
		4	0.2386	-5.3822	0.0000
		8	0.1253	-4.4023	0.0000
		16	0.0592	-3.4260	0.0006

Source: Authors' Own Compilation

5.3. Non - Parametric Test

5.3.1. Runs Test

The study is based on non-parametric variables. The statistical tool of runs test is applied to the data to test the randomness in the return series of selected companies for pre-pandemic and during pandemic periods. Results are given in table 8 and table 9 respectively. Runs test checks the hypothesis of two-tailed data sequences and also checks the statistical independence of the time series. It is a statistical procedure that is used in examining whether, in a given sequence of observations, the value of one observation is based on subsequent observations. It is considered that observation values are independent of each other and complete sequences are random in nature.

5.3.1.1. Runs Test of Selected Companies for the Pre-Pandemic Period

Table 8 reveals that at a 5% level of significance Z values of all the companies in the pre-pandemic period are below a critical value (±1.96) except PEL.NS. It means accepting a null hypothesis that there is a randomness in the series of all companies during a pre-pandemic period except PEL.NS (2.44).

Table 8: Runs Test Values for Pre-Pandemic Period

Sr. No.	*Name of the company*	*Count of Runs*	*Value of Z*	*2 Tailed Asymp. Sign*	*S/NS*
1	SUNPHARMA.NS	115	0.679	0.497	S
2	DIVISLAB.NS	116	0.815	0.415	S
3	CIPLA.NS	116	0.815	0.415	S
4	APOLLOHOSP.NS	118	1.086	0.277	S
5	DRREDDY.NS	117	0.950	0.342	S
6	PEL.NS	128	2.444	0.015	NS
7	TORNTPHARM.NS	112	0.272	0.786	S
8	ALKEM.NS	114	0.543	0.587	S
9	AUROPHARMA.NS	118	1.086	0.277	S
10	BIOCON	118	1.086	0.277	S

Source: Authors' Own Compilation

5.3.1.2. Runs Test of Selected Companies During Pandemic Period

Table 9 reveals that at a 5% level of significance Z values of all the companies during the pandemic period are below a critical value (±1.96) except TORNTPHARM.NS. It means accepting a null hypothesis that there is a randomness in the series of all companies during a pandemic period except TORNTPHARM.NS (2.05).

Table 9: Runs Test Values During Pandemic Period

Sr. No.	*Name of the company*	*Count of Runs*	*Value of Z*	*2 Tailed Asymp. Sign*	*S/NS*
1	SUNPHARMA.NS	252	1.863	0.062	S
2	DIVISLAB.NS	242	0.931	0.352	S
3	CIPLA.NS	243	1.025	0.306	S
4	APOLLOHOSP.NS	228	-0.373	0.709	S
5	DRREDDY.NS	230	-0.186	0.852	S
6	PEL.NS	222	-0.931	0.352	S
7	TORNTPHARM.NS	254	2.049	0.040	NS
8	ALKEM.NS	225	-0.652	0.514	S
9	AUROPHARMA.NS	226	-0.559	0.576	S
10	BIOCON	230	-0.186	0.852	S

Based on the median (S=Significance and NS = Non-significance.)

Source: Authors' Own Compilation

6. Summary and Conclusion

This paper has examined the weak form efficiency of the top 10 Indian pharmaceutical companies in pre-pandemic and during pandemic periods. By applying the ADF test, Variance Ratio Test, and Runs test, it is examined that the Indian pharmaceutical sector has randomness in stock prices.

During pre-pandemic period all companies have positive returns except SUNPHARMA.NS, CIPLA.NS, PEL.NS, AUROPHARMA.NS whereas during the pandemic period all selected companies have positive returns. Companies like SUNPHARMA.NS, DIVISLAB.NS, PEL.NS, and BIOCON are negatively skewed in the pre-pandemic period but during the pandemic including them, all selected companies are positively skewed. ADF unit root test examined that in both selected periods all companies have stationarity in the return series. Multiple variance ratio tests proved that all companies' return series have heteroscedasticity in return series in both selected periods. Runs test proved that in the pre-pandemic period except for PEL.NS, all other companies have randomness in the stock prices, whereas during the pandemic period except TORNTPHARM.NS, all other companies' return series have randomness. Out of selected companies, the majority of companies have return series random in nature.

That means the pharmaceutical sector stock prices are not under the impact of any pattern. The scripts are not using historical information. The change in stock prices is independent of each other. According to runs test results, all top NSE-listed pharmaceutical companies' share prices have moved randomly. Their historical movement of prices or trend of stock prices cannot be used in forecasting the market rates of stocks. This means that future prices are not based on past prices of stocks and they cannot be predicted as they follow random walks. Investors cannot benefit from the past prices of these companies as also suggested by (Mathivannan and Selvakumar, 2015). Price prediction is very difficult for investors as well as analysts for the pharmaceutical sector as it follows random walks.

Technical analysis is not helpful in forecasting new prices. The investors have to depend on the information efficiency rather than depending on old prices. There is less scope for speculative activities in the pharmaceutical sector of the Indian stock market.

On the basis of the study, it is observed that India has to implement appropriate policies for improving the efficiency of stock markets. The closing prices of all pharmaceutical sector companies cannot be predicted by the investors on the basis of past prices or any historical information about these stocks. It shows no connectivity in current and old rates of stocks (Thomas and Dileep, 2010). There is no chance to earn abnormal returns in all these scripts. This shows that for these stocks historical prices are not beneficial on which one can predict the future prices of these stocks. This is a result of information symmetric or efficiency in the stock market of India. It also shows that the stock prices are independent. Indian markets are less manipulative and efficient in providing information equally and freely to their investors. There is less chance of taking the help of manipulative activities to earn an abnormal profit based on changes happening in old prices. As the study shows that there is no chance for the manipulation of prices of these stocks, it is advisable for investors to depend on the efficiency of the stock market. It is also very difficult to predict the future prices of these stocks which results in no chance for speculative activities in the stock market.

Based on the present study, we also suggest that all regulatory bodies should take special efforts in attracting small, medium, and foreign investors towards investment in listed stocks of Indian stock markets. The trading volume will increase, which will be helpful to reduce profitable trading in the Indian stock market. The current study is based on only the pharmaceutical sector of India. There is a future scope to do the study on different industrial sectors of India as well as of other countries and do the comparison between them, which will help to understand the stock markets behavior of various countries in different sectors. Not only that, by taking into consideration, the growing integration of Indian financial markets with other countries, there is a need to understand the correlation between daily Indian stock prices with other countries' stock prices of various sectors.

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