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Influence of Periodicity Bias on the Market Efficiency: Empirical Evidences from Indian Stock Markets

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Abstract:

In recent year's investors, portfolio managers and researchers have been keenly engaged in studying the behaviour of stock market prices and a market is considered efficient if its mechanism is vibrant enough to reflect relevant information in the prevailing stock price. In academics, market efficiency is sub-divided into three forms- 'weak', 'semi-strong' and 'strong'. In this research paper, an attempt has been made to examine the stock market efficiency in weak form by keeping the discussion a realistically logical and simple. Weak form stipulates that current prices of stock already fully reflect all the information that is obtained in the historical sequence prices. It is examine with the help of statistical tool- serial correlation on the sample monthly stock prices of 152 companies of BSE from 1st January to 31st December 2007. It concludes that successive price changes were independent of the previous month price changes.

1. Introduction

In recent years investors, portfolio managers and researchers have been keenly engaged in studying the behaviour of stock market prices. This quest is becoming even greater with every passing day among all herds and breeds of market participants in an apparent bid to outperform the other. Academicians not lagging behind and are taking keen interest in developing and verifying different models to explain and confirm stock price (return) behaviour. Today, the knowledge inputs so generated have crystallized to be known as basic tenants of investment management. Stock market efficiency edifice is based on these fickle and volatile market conditions. The fund managers examine market conditions to advice investors and construct a portfolio analysis.

In an efficient stock market competition among many intelligent participants leads to a situation where actual prices of securities reflects the effects of events that have already occurred and the events which are, as of now, expected to take place in the future. The degree to which markets are efficient has important implications for investors. In perfectly efficient markets time, effort and money spent on security analysis will be a waste. If some sectors of the securities market are less efficient than others, efforts devoted to discover mispriced securities should be directed to less efficient sectors. The efficient market hypothesis is based on the following premises:

- All investors have costless access to current available information about the future;
- All investors are good analysts; and
- All investors pay close attention to market prices and adjust their holdings accordingly.

In academics, market efficiency is sub-divided into three forms. A distinction is made between potential levels of efficiency- 'weak', 'semi-strong' and 'strong'—each related to a specific set of information, which is increasingly more comprehensive than the previous one. Weak form stipulates that current prices of stock already fully reflect all the information that is obtained in the historical sequence prices. It suggests that charts and technical analyses based on the best prices alone would not be useful in finding undervalued stocks. Semi-strong form of market efficiency, the current stock price reflects the information contained not only in past prices but all public information (financial statements and news reports). The stock markets in the US strongly support semi-strong hypothesis as stock prices adjust rapidly to the new information. The strong form version of efficient market hypothesis states that stock prices reflect all information relevant to the firm, even including information available only to company insiders. This implies that not even security analyst and portfolio managers, who have access to information more quickly that the general investing public, are able to use this information to earn superior returns.

Needless to say, three levels of market efficiency are not independent of one another. For the market to be efficient in strong form it must also be efficient at the two lower levels, otherwise the price would not capture all relevant information. The debate about stock market efficiency has resulted in hundreds of empirical studies attempting to determine whether specific market are in fact 'efficient' and if so, to what degree? Many novice investors are surprised to learn that a tremendous amount of evidence supports the efficient

market hypothesis. And in fact, the vast majority of studies of technical theories has founded the strategies to be completely useless in predicting securities prices. However, researchers have documented some technical analysis that may offer some hope for technicians, although transactions costs may reduce or eliminate any advantage.

In a nutshell, a market is considered efficient if its mechanism is vibrant enough to reflect relevant information in the prevailing stock price. The efficient market is one where the market price is an unbiased estimator of the true value of the investment.

Numerous studies have been conducted, particularly in the second half of the twentieth century, to test the stock market efficiency world over. These studies have produced incredible evidence supporting market efficiency across the globe. The results obtained were considered robust in the weak form of efficiency. Occasionally, studies negating these findings were also noticed over these years. Developed stock markets (American, European, and Japanese) have also culminated enough research evidence to brand stock markets efficient in the semi strong form as well. However, in developing economies like India, this aspect of market efficiency is still being debated. On the other hand, strong form of market efficiency today is as contentious, as it has ever been world over. In this research paper, an attempt has been made to examine the stock market efficiency in weak form by keeping the discussion a realistically logical and simple.

2. Literature Review

In India, a number of attempts have been made to examine stock market efficiency in the weak form. Mukhrjee (1971)¹ produced results supporting weak form efficiency on the basis of stock prices of a single company (Indian Aluminium). They used spectral analysis to test the random walk model by using the weekly average prices over a 16- year period (1955-70).

Sharma (1983)⁶ examined stock price behavior of 23 stocks listed on the Bombay stock exchange for the six year period from 1973-78 using Integrated Moving Average (IMA) form of the random walk model confirmed the (random) behavior of stock price changes in India. Rao (1988)⁹ examined weekend price data over the period July 1982-June 1987 for 10 blue chip stocks by means of serial correlation analysis, runs the tests and filter rules of 3percent , 5percent and 10 percent. The study provided evidence in support of random walk hypothesis.

Pandey and Bhatt (1988)¹⁰ studied the attitudes and perceptions of chartered accountants, academicians, investors, brokers and chief financial executives of companies about the efficiency of stock markets through structured questionnaire and concluded that the efficiency of the Indian stock market is doubtful. Gupta (1990)¹¹ tested the appropriateness of the random walk model for a period from April 1979 to December 1987, using data of prices for five indices of shares traded on BSE during this period. This led Gupta to conclude that a random walk model is an appropriate model to describe equity price behavior in India and that; "Bombay Stock Exchange may be termed as competitive and weakly efficient in pricing shares.

Chaudhary (1991)¹⁴ has also tested the log random walk model and reached on some different conclusion. The study used daily price quotations of 93 actively traded shares on the Bombay Stock Exchange during the period January 1988- April 1990 to have significance for auto correlation for one-day lag. The findings reported in the Study attributed market pricing efficiency to individual shares. On the contrary, Belguami (1995)¹⁵ made an effort to test the weak form of efficiency based on the analysis of stock prices of 70 groups- A companies on the Bombay Stock Exchange, using different parametric and non-parametric tests, the study concluded that Indian Stock Markets were weakly efficient in pricing their shares. Mitra (2000)¹⁶ concluded an empirical study with BSE-sensex and found profitable trading opportunity in Indian Stock Market. He observed that returns exhibit positive serial correlation in short-term and when the effect of any information is not quickly absorbed in the price; the possibility of share adjustment causes serial correlation.

3. Objective of the Study

The study under consideration is considered primarily with the objective to provide systematic and logically sound explanations to following questions:

- Are the prices really moving as the random numbers behaves?
- Do the prices over a period of time have sufficient serial dependence to allow investors to predict future price movements by studying past price –trends?

4. Hypotheses

The present study is based on the following hypothesis:

H₁ "The successive share price changes in Indian Capital Market are not dependent on the past price movements".

The main purpose of this study is to make an analysis of monthly stock prices. The sample for this study consists of 152 companies of Bombay Stock Exchange (BSE's) has taken for better representation. To get the good conclusion of the study all companies are taking on a random basis. Data related to ten years starting from the 1st January 1998 to 31st December 2007 is taken to make the study effective.

The present study is of analytical and explorative in nature. To complete the study, data are collected purely from secondary sources. After the data collection, it is examined with the help of statistical tool- serial correlation. The results of serial correlation on monthly prices are tabulated in proper form. After tabulation the results, deeply analysis and interpretation has done.

5. Serial Correlation Test

In order to test the independence between successive price changes serial correlation is used. Serial correlation measures the correlation co-efficient in a series of numbers with the lagging values of the same series. If correlation lies between +1 and -1, positive sign indicates direct correlation, negative sign indicates an inverse correlation and a value close to zero implies that price changes are said to be serially independent. It means that prices move in a random fashion and are not dependent on past prices.

Serial correlation coefficients (r_k) provide a measure of the relationship between the value of a random variable in time (t) and its value (k) periods earlier. It indicates whether a price change in time (t) is influenced by the price changes occurring (k) periods earlier. The serial correlation of a time series is given by auto-correlation function of lag k. It (r_k) is estimated (Chatfield, 1980, p. 25) by using:

$$r_k = C_k / C_0$$

Wherein

$$C_k = \frac{1}{N} \sum_{t=1}^{n-k} (X_t - \bar{X})(X_{t+k} - \bar{X})$$

$$K = 0, 1, \dots$$

$$\bar{X} = \frac{1}{N} \sum_{t=1}^n X_t$$

$$C_0 = \text{Variance of } X_t$$

Statistical testing of the serial correlation coefficients requires the standard error of estimated coefficients, which is given by:

$$\text{S.E. } (r_k) = \frac{1}{\sqrt{n-k}}$$

For null hypothesis to be true, observed serial correlation should not be statically significant.

6. Empirical Results

Using the data set and methodology defined above, this section discusses the empirical results of serial correlation on monthly stock prices to investigate the random walk hypothesis as well as market efficiency.

Another way to test for randomness in stock price changes is to look at their serial correlations also called auto-correlations co-efficient. The serial correlation test is used to examine the serial independence of stock prices in the study. It shows the pattern of autocorrelations present in the time-series as well as the extent to which current values of the series are related to various lags of the past data. In the absence of serial dependence of stock prices, the result will support the weak form market efficiency. The empirical results of serial correlation performed out on the monthly stock prices of 152 share price series, were computed for lags 1 to 16 during the study period, 1998-2007 are reported in table 1 as under:

Company Name	Lags															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A B B Ltd.	0.028	-0.159*	0.027	0.072	-0.068	0.056	-0.057	-0.028	-0.077	0.057	-0.033	0.06	-0.063	-0.051	-0.026	-0.017
Abbott India Ltd.	-0.142*	0.216*	-0.125*	0.019	-0.171*	-0.054	-0.076	0.008	0.063	0.167*	-0.053	0.066	-0.035	0.042	0.042	-0.006
Aditya Birla Nuvo Ltd.	-0.059	-0.102*	-0.007	-0.04	-0.097*	0.214*	-0.022	-0.009	0.025	-0.205*	-0.033	0.258*	0.018	0.148*	-0.049	-0.05
Alfa Laval (India) Ltd.	-0.048	-0.156*	-0.163*	0.148*	0.116*	-0.064	-0.091*	-0.091*	0.042	0.132*	0.086	-0.237*	-0.021	0.092*	0.234*	-0.047
Alok Industries Ltd.	0.047	-0.223*	0.076	-0.154*	0.03	0.246*	-0.054	-0.035	0.022	-0.132*	0.04	0.139*	-0.108*	0.008	0.034	-0.083
Ambuja Cement Eastern Ltd.	-0.063	-0.062	0.008	-0.06	-0.005	-0.001	-0.053	-0.072	0.076	0	-0.166*	0.055	-0.009	-0.01	0.229*	0.017
Apollo Hospitals Enterprise Ltd.	0.131*	0.097*	0.019	-0.029	0.156*	0.055	0.23	-0.148*	-0.212*	0.048	-0.048	-0.111*	-0.064	-0.088*	-0.028	-0.097*
Apollo Tyres Ltd.	0.131*	0.05	-0.139*	-0.075	-0.065	0.052	-0.108*	-0.028	-0.16*	0.009	-0.025	-0.034	-0.052	-0.04	-0.023	0.172*
Arvind Mills Ltd.	0.093*	-0.018	-0.011	0.006	0.099*	0.199*	-0.056	0.076	-0.01	-0.077	0.107*	0.113*	0.054	0.009	0.129*	0.048
Asahi India Glass Ltd.	0.054	-0.011	0.027	-0.009	0.004	-0.149*	-0.076	-0.133*	-0.123*	-0.036	-0.088	-0.102*	-0.059	0.091*	0.123*	0.081
Ashok Leyland Ltd.	0.059	0.037	0.034	-0.064	-0.003	-0.02	-0.007	-0.082	0.03	-0.133*	-0.101*	-0.072	-0.106*	-0.013	-0.004	0.058
Asian Paints Ltd.	-0.068	0.166*	-0.196*	-0.098*	0.006	-0.023	0.116*	-0.013	-0.039	0.103*	-0.008	-0.138*	-0.106*	-0.17*	0.079	0.057
Aurobindo Pharma Ltd.	0.026	-0.031	-0.162*	-0.039	-0.005	0.011	0.079	-0.036	-0.042	0.153*	0.05	0.077	-0.103*	-0.157*	0.051	0.085
Aventis Pharma Ltd.	0.008	0.047	-0.118*	0.006	0.05	-0.026	-0.07	-0.045	0.128*	0.049	0.066	-0.014	-0.061	-0.104*	0.11*	-0.054
B A S F India Ltd.	-0.011	0.033	-0.001	0.051	-0.038	-0.023	-0.064	-0.14*	0.003	0.035	-0.006	0.048	-0.04	0.194*	-0.015	0.111*
Bajaj Auto Ltd.	-0.035	0.102*	0.022	0.011	0.098*	0.042	-0.151*	0.049	-0.04	0.196*	-0.066	0.078	-0.052	-0.03	-0.038	0.001
Ballarpur Industries Ltd.	0.032	-0.096*	0.048	-0.203*	-0.072	-0.011	-0.006	0.014	0.005	-0.003	-0.056	-0.087	-0.096*	0.072	-0.087	0.136*
Bank Of Baroda	-0.045	0.106*	-0.007	-0.037	0.083	-0.069	-0.11*	-0.028	-0.138*	-0.011	-0.045	0.033	0.059	-0.024	0.012	0.149*
Bank Of India	0.047	0.075	-0.048	-0.079	-0.051	-0.026	0.046	0.193*	-0.036	0.007	0.011	-0.138*	0.006	0.043	0.056	0.135*
Bharat Earth Movers Ltd.	0.178*	-0.073	-0.001	0.009	0.041	-0.035	-0.068	-0.163*	-0.018	0.059	0.014	0.042	-0.129*	-0.075	0.048	0.23*
Bharat Electronics Ltd.	0.055	-0.187*	-0.124*	0.093*	0.112*	0.069	-0.199*	-0.255*	-0.062	0.119*	-0.027	-0.198*	-0.125*	0.06	0.033	0.122*
Bharat Forge Ltd.	0.059	-0.004	0.11	-0.095*	0.043	-0.018	-0.132*	0.007	0.031	0.088	-0.019	-0.101*	-0.014	0.033	0.016	-0.018
Bharat Heavy Electricals Ltd.	0.054	-0.061	-0.055	-0.048	0.053	0.085	-0.071	-0.126*	0.045	0.11*	0.019	0.03	-0.133*	0.024	-0.015	0.011
Bharat Petroleum Corpn. Ltd.	-0.142*	-0.019	-0.005	0.033	-0.044	0.026	-0.208*	0.074	-0.133*	0.038	-0.117*	0.033	-0.041	0.017	-0.038	0.028
Birla Corporation Ltd.	0.092	0.016	-0.062	-0.066	0.023	0.011	-0.041	0.056	-0.055	-0.016	0.02	-0.009	0.056	0.102*	-0.027	0.15*
Bombay Dyeing & Mfg. Co. Ltd.	0.173*	-0.193*	-0.055	-0.026	0.066	0.01	-0.022	-0.034	0.016	-0.062	0.003	0.128*	-0.062	-0.08	0.021	0.069
Bongaigaon Refinery & Petrochemicals Ltd.	0.026	0.031	0.215*	-0.08	-0.082	-0.053	0.069	-0.098*	-0.081	-0.173*	0.018	0.126*	-0.084	0.215*	0.257*	0.059
Britannia Industries Ltd.	0.142*	0.173*	-0.01	0.07	0.118*	0.042	-0.014	-0.106*	-0.144*	-0.102*	-0.047	0.003	-0.083	-0.04	0	0.102*
C E S C Ltd.	0.121*	-0.012	-0.115*	-0.01	0.037	0.291*	-0.104*	-0.135*	-0.086	-0.055	0.003	0.167*	0.029	-0.031	-0.004	0.161*
C M C Ltd.	0.191*	-0.188*	-0.163*	-0.042	0.136*	-0.036	-0.031	-0.031	-0.119*	0.134*	0.184*	0.08	-0.066	-0.231*	-0.005	0.082
Castrol India Ltd.	-0.017	-0.067	-0.118*	-0.041	-0.01	-0.054	0.012	-0.027	0.065	0.056	-0.099*	0.029	0.009	0.075	-0.089*	0.142*
Century Enka Ltd.	0.049	-0.069	0.052	-0.023	-0.113*	0.014	-0.036	-0.039	0.004	-0.006	-0.189*	-0.108*	-0.111*	-0.015	-0.079	0.147*
Century Textiles & Inds. Ltd.	0.02	-0.128*	-0.039	-0.201*	-0.026	0.021	0.122*	0.057	-0.105*	0.008	-0.071	0.03	-0.026	-0.104*	-0.018	0.064
Chambal Fertilisers & Chemicals Ltd.	-0.115*	-0.125*	-0.029	0.115*	-0.07	-0.022	0.018	0.172*	-0.019	-0.084	-0.135*	0.172*	-0.047	0.081	0.022	0.036
Chennai Petroleum Corpn. Ltd.	0.077	-0.126*	0.085	-0.049	-0.048	-0.002	0.124*	0.028	-0.147*	-0.048	0.027	-0.028	-0.013	0.252*	0.047	0.047
Cipla Ltd.	-0.126*	-0.057	0.018	-0.035	0.013	0.034	-0.112*	-0.036	-0.05	-0.048	0.034	-0.088	-0.025	0.017	0.003	0.026
Colgate-Palmolive (India) Ltd.	0.089	0.034	-0.094*	-0.079	0.068	-0.067	0.02	-0.048	0.025	-0.025	-0.046	-0.085	0.017	0.066	-0.12*	0.168*
Container Corpn. Of India Ltd.	0.096*	0.066	0.116*	-0.07	0.03	-0.036	-0.084	-0.088	-0.128*	-0.131*	0.006	0.007	0.103*	-0.017	0.162*	0.222*
Corporation Bank	-0.148*	0.106*	-0.2	-0.025	0.017	0.048	-0.104*	0.122*	-0.125*	-0.02	-0.107*	-0.032	-0.032	-0.057	0.129*	0.002
Crompton Greaves Ltd.	-0.003	-0.081	0.068	-0.039	-0.074	-0.04	0.057	-0.002	0.015	-0.043	-0.169*	0.079	-0.1*	0.048	0.066	-0.028
Cummins India Ltd.	-0.016	-0.014	0.04	0.097*	0.007	0.033	0.091*	0.12*	-0.001	-0.001	0.01	-0.085	0.036	0.072	-0.143*	0.05
Dabur India Ltd.	0.013	0.013	-0.017	0.03	-0.01	-0.009	0.114*	0.034	0.125*	-0.022	-0.078	-0.031	0.025	-0.075	-0.049	-0.04
Dena Bank	0.036	0.022	-0.115*	-0.037	-0.105*	-0.03	-0.171*	0.395*	0.035	-0.089	0.003	-0.001	-0.007	0.101*	-0.169*	0.182*
Dr. Reddy'S Laboratories Ltd.	-0.048	-0.103*	0.068	-0.148*	0.041	0.11*	-0.077	-0.012	0.095*	-0.058	0.085	0.146*	-0.091*	-0.119*	-0.096*	-0.014
Dredging Corpn. Of India Ltd.	0.048	-0.133*	0.046	-0.04	-0.061	0.078	0.023	-0.09	-0.175*	-0.023	0.151*	-0.017	-0.099*	-0.066	0.009	0.048
E I H Ltd.	-0.057	-0.049	0.034	-0.062	-0.017	-0.087	-0.046	-0.048	-0.001	-0.029	-0.001	0.018	-0.011	-0.026	-0.001	-0.077
Engineers India Ltd.	0.092	0.095*	0.073	-0.064	-0.04	-0.101*	-0.099*	-0.213*	0.039	0.177*	-0.017	-0.1*	0.082	-0.038	0.154*	0.083
Escorts Ltd.	0.039	-0.108*	-0.157*	-0.101*	0.053	0.1*	-0.006	-0.082	-0.089	-0.025	0.007	-0.074	-0.049	-0.102*	0.1*	0.182*
Essel Propack Ltd.	0.04	-0.095*	0.049	-0.034	0.042	-0.009	-0.098*	-0.103*	0.018	-0.034	0.007	0.019	-0.009	-0.038	-0.025	0.03
Exide Industries Ltd.	-0.03	-0.084	-0.043	-0.016	0.073	-0.007	-0.109*	-0.099*	-0.035	0.109*	0.029	-0.027	-0.051	-0.011	0.04	0.005
F D C Ltd.	-0.084	0.038	0.032	-0.051	0.03	0.019	-0.027	-0.006	0.036	-0.017	0.018	-0.022	-0.11*	0.013	-0.139*	0.013
Federal Bank Ltd.	-0.059	-0.05	0.145*	-0.123*	0.094*	-0.031	-0.066	-0.092*	-0.072	0.089	-0.084	-0.07	0.032	-0.006	0.08	0.074
Finolex Cables Ltd.	-0.053	0.001	-0.008	0.035	-0.031	-0.004	-0.121*	-0.001	-0.18*	0.019	-0.076	0.021	-0.032	0.036	0.03	0.044
Finolex Industries Ltd.	-0.014	-0.125*	0.189*	0.021	-0.045	0.106*	-0.085	-0.183*	0.01	-0.089	-0.116*	-0.063	-0.217*	0.094*	-0.029	-0.079

Company Name	Lags															
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Arvind Mills Ltd.	0.093*	-0.018	-0.011	0.006	0.099*	0.199*	-0.056	0.076	-0.01	-0.077	0.107*	0.113*	0.054	0.009	0.129*	0.048
Asahi India Glass Ltd.	0.054	-0.011	0.027	-0.009	0.004	-0.149*	-0.076	-0.133*	-0.123*	-0.036	-0.088	-0.102*	-0.059	0.091*	0.123*	0.081
Ashok Leyland Ltd.	0.059	0.037	0.034	-0.064	-0.003	-0.02	-0.007	-0.082	0.03	-0.133*	-0.101*	-0.072	-0.106*	-0.013	-0.004	0.058
Asian Paints Ltd.	-0.068	0.166*	-0.196*	-0.098*	0.006	-0.023	0.116*	-0.013	-0.039	0.103*	-0.008	-0.138*	-0.106*	-0.17*	0.079	0.057
Aurobindo Pharma Ltd.	0.026	-0.031	-0.162*	-0.039	-0.005	0.011	0.079	-0.036	-0.042	0.153*	0.05	0.077	-0.103*	-0.157*	0.051	0.085
Aventis Pharma Ltd.	0.008	0.047	-0.118*	0.006	0.05	-0.026	-0.07	-0.045	0.128*	0.049	0.066	-0.014	-0.061	-0.104*	0.11*	-0.054
B A S F India Ltd.	-0.011	0.033	-0.001	0.051	-0.038	-0.023	-0.064	-0.14*	0.003	0.035	-0.006	0.048	-0.04	0.194*	-0.015	0.111*
Bajaj Auto Ltd.	-0.035	0.102*	0.022	0.011	0.098*	0.042	-0.151*	0.049	-0.04	0.196*	-0.066	0.078	-0.052	-0.03	-0.038	0.001
Ballarpur Industries Ltd.	0.032	-0.096*	0.048	-0.203*	-0.072	-0.011	-0.006	0.014	0.005	-0.003	-0.056	-0.087	-0.096*	0.072	-0.087	0.136*
Bank Of Baroda	-0.045	0.106*	-0.007	-0.037	0.083	-0.069	-0.11*	-0.028	-0.138*	-0.011	-0.045	0.033	0.059	-0.024	0.012	0.149*
Bank Of India	0.047	0.075	-0.048	-0.079	-0.051	-0.026	0.046	0.193*	-0.036	0.007	0.011	-0.138*	0.006	0.043	0.056	0.135*
Bharat Earth Movers Ltd.	0.178*	-0.073	-0.001	0.009	0.041	-0.035	-0.068	-0.163*	-0.018	0.059	0.014	0.042	-0.129*	-0.075	0.048	0.23*
Bharat Electronics Ltd.	0.055	-0.187*	-0.124*	0.093*	0.112*	0.069	-0.199*	-0.255*	-0.062	0.119*	-0.027	-0.198*	-0.125*	0.06	0.033	0.122*
Bharat Forge Ltd.	0.059	-0.004	0.11	-0.095*	0.043	-0.018	-0.132*	0.007	0.031	0.088	-0.019	-0.101*	-0.014	0.033	0.016	-0.018
Bharat Heavy Electricals Ltd.	0.054	-0.061	-0.055	-0.048	0.053	0.085	-0.071	-0.126*	0.045	0.11*	0.019	0.03	-0.133*	0.024	-0.015	0.011
Bharat Petroleum Corp. Ltd.	-0.142*	-0.019	-0.005	0.033	-0.044	0.026	-0.208*	0.074	-0.133*	0.038	-0.117*	0.033	-0.041	0.017	-0.038	0.028
Birla Corporation Ltd.	0.092	0.016	-0.062	-0.066	0.023	0.011	-0.041	0.056	-0.055	-0.016	0.02	-0.009	0.056	0.102*	-0.027	0.15*
Bombay Dyeing & Mfg. Co. Ltd.	0.173*	-0.193*	-0.055	-0.026	0.066	0.01	-0.022	-0.034	0.016	-0.062	0.003	0.128*	-0.062	-0.08	0.021	0.069
Bongaigaon Refinery & Petrochemicals Ltd.	0.026	0.031	0.215*	-0.08	-0.082	-0.053	0.069	-0.098*	-0.081	-0.173*	0.018	0.126*	-0.084	0.215*	0.257*	0.059
Britannia Industries Ltd.	0.142*	0.173*	-0.01	0.07	0.118*	0.042	-0.014	-0.106*	-0.144*	-0.102*	-0.047	0.003	-0.083	-0.04	0	0.102*
C E S C Ltd.	0.121*	-0.012	-0.115*	-0.01	0.037	0.291*	-0.104*	-0.135*	-0.086	-0.055	0.003	0.167*	0.029	-0.031	-0.004	0.161*
C M C Ltd.	0.191*	-0.188*	-0.163*	-0.042	0.136*	-0.036	-0.031	-0.031	-0.119*	0.134*	0.184*	0.08	-0.066	-0.231*	-0.005	0.082
Castrol India Ltd.	-0.017	-0.067	-0.118*	-0.041	-0.01	-0.054	0.012	-0.027	0.065	0.056	-0.099*	0.029	0.009	0.075	-0.089*	0.142*
Century Enka Ltd.	0.049	-0.069	0.052	-0.023	-0.113*	0.014	-0.036	-0.039	0.004	-0.006	-0.189*	-0.108*	-0.111*	-0.015	-0.079	0.147*
Century Textiles & Inds. Ltd.	0.02	-0.128*	-0.039	-0.201*	-0.026	0.021	0.122*	0.057	-0.105*	0.008	-0.071	0.03	-0.026	-0.104*	-0.018	0.064
Chambal Fertilisers & Chemicals Ltd.	-0.115*	-0.125*	-0.029	0.115*	-0.07	-0.022	0.018	0.172*	-0.019	-0.084	-0.135*	0.172*	-0.047	0.081	0.022	0.036
Chennai Petroleum Corp. Ltd.	0.077	-0.126*	0.085	-0.049	-0.048	-0.002	0.124*	0.028	-0.147*	-0.048	0.027	-0.028	-0.013	0.252*	0.047	0.047
Cipla Ltd.	-0.126*	-0.057	0.018	-0.035	0.013	0.034	-0.112*	-0.036	-0.05	-0.048	0.034	-0.088	-0.025	0.017	0.003	0.026
Colgate-Palmolive (India) Ltd.	0.089	0.034	-0.094*	-0.079	0.068	-0.067	0.02	-0.048	0.025	-0.025	-0.046	-0.085	0.017	0.066	-0.12*	0.168*
Container Corp. Of India Ltd.	0.096*	0.066	0.116*	-0.07	0.03	-0.036	-0.084	-0.088	-0.128*	-0.131*	0.006	0.007	0.103*	-0.017	0.162*	0.222*
Corporation Bank	-0.148*	0.106*	-0.2	-0.025	0.017	0.048	-0.104*	0.122*	-0.125*	-0.02	-0.107*	-0.032	-0.032	-0.057	0.129*	0.002
Crompton Greaves Ltd.	-0.003	-0.081	0.068	-0.039	-0.074	-0.04	0.057	-0.002	0.015	-0.043	-0.169*	0.079	-0.1*	0.048	0.066	-0.028
Cummins India Ltd.	-0.016	-0.014	0.04	0.097*	0.007	0.033	0.091*	0.12*	-0.001	-0.001	0.01	-0.085	0.036	0.072	-0.143*	0.05
Dabur India Ltd.	0.013	0.013	-0.017	0.03	-0.01	-0.009	0.114*	0.034	0.125*	-0.022	-0.078	-0.031	0.025	-0.075	-0.049	-0.04
Dena Bank	0.036	0.022	-0.115*	-0.037	-0.105*	-0.03	-0.171*	0.395*	0.035	-0.089	0.003	-0.001	-0.007	0.101*	-0.169*	0.182*
Dr. Reddy'S Laboratories Ltd.	-0.048	-0.103*	0.068	-0.148*	0.041	0.11*	-0.077	-0.012	0.095*	-0.058	0.085	0.146*	-0.091*	-0.119*	-0.096*	-0.014
Dredging Corp. Of India Ltd.	0.048	-0.133*	0.046	-0.04	-0.061	0.078	0.023	-0.09	-0.175*	-0.023	0.151*	-0.017	-0.099*	-0.066	0.009	0.048
E I H Ltd.	-0.057	-0.049	0.034	-0.062	-0.017	-0.087	-0.046	-0.048	-0.001	-0.029	-0.001	0.018	-0.011	-0.026	-0.001	-0.077
Engineers India Ltd.	0.092	0.095*	0.073	-0.064	-0.04	-0.101*	-0.099*	-0.213*	0.039	0.177*	-0.017	-0.1*	0.082	-0.038	0.154*	0.083
Escorts Ltd.	0.039	-0.108*	-0.157*	-0.101*	0.053	0.1*	-0.006	-0.082	-0.089	-0.025	0.007	-0.074	-0.049	-0.102*	0.1*	0.182*
Essel Propack Ltd.	0.04	-0.095*	0.049	-0.034	0.042	-0.009	-0.098*	-0.103*	0.018	-0.034	0.007	0.019	-0.009	-0.038	-0.025	0.03
Exide Industries Ltd.	-0.03	-0.084	-0.043	-0.016	0.073	-0.007	-0.109*	-0.099*	-0.035	0.109*	0.029	-0.027	-0.051	-0.011	0.04	0.005
F D C Ltd.	-0.084	0.038	0.032	-0.051	0.03	0.019	-0.027	-0.006	0.036	-0.017	0.018	-0.022	-0.11*	0.013	-0.139*	0.013
Federal Bank Ltd.	-0.059	-0.05	0.145*	-0.123*	0.094*	-0.031	-0.066	-0.092*	-0.072	0.089	-0.084	-0.07	0.032	-0.006	0.08	0.074
Finolex Cables Ltd.	-0.053	0.001	-0.008	0.035	-0.031	-0.004	-0.121*	-0.001	-0.18*	0.019	-0.076	0.021	-0.032	0.036	0.03	0.044
Finolex Industries Ltd.	-0.014	-0.125*	0.189*	0.021	-0.045	0.106*	-0.085	-0.183*	0.01	-0.089	-0.116*	-0.063	-0.217*	0.094*	-0.029	-0.079

Company Name	Lags															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
National Aluminium Co. Ltd.	-0.039	0.122*	-0.029	0.043	-0.026	-0.111*	-0.133*	-0.162*	0.034	-0.265*	-0.081	0.004	-0.079	0.055	-0.014	0.092*
National Fertilizers Ltd.	0.293*	0.199*	-0.096*	-0.068	-0.049	0.062	-0.002	0.112*	-0.154*	0.063	-0.092*	0.183*	0.11*	0.187*	0.069	0.086
Nestle India Ltd.	-0.117*	0.157*	-0.195*	0.175*	-0.067	-0.032	-0.143*	0.021	-0.051	-0.015	-0.088	0.036	-0.164*	0.124*	-0.158*	0.174*
Neyveli Lignite Corp. Ltd.	-0.021	-0.067	0.143*	-0.043	-0.163*	0.096*	-0.225*	0.063	0.074	-0.027	-0.093*	0.168*	-0.005	0.001	0.038	0.143*
Nicholas Pharam India Ltd.	0.062	0.017	0.011	0.009	-0.087	-0.012	0.059	-0.091*	-0.026	0.074	-0.003	-0.08	-0.062	-0.045	-0.055	0.009
Nirma Ltd.	-0.044	-0.024	0.028	0.11*	0.067	0.157*	-0.058	-0.015	-0.065	-0.02	-0.002	0.042	-0.139*	-0.048	-0.01	-0.132*
Novartis India Ltd.	-0.034	0.176*	0.13*	-0.053	0.214*	0.019	0.034	0.123*	0.079	0.054	0.081	-0.016	0.067	-0.031	0.011	-0.011
Oil & Natural Gas Corp. Ltd.	0.136*	-0.135*	0.112*	-0.008	-0.172*	-0.068	0.089	-0.04	-0.074	0.066	-0.074	-0.077	0.054	0.074	0.02	-0.039
Orchid Chemicals & Pharmaceuticals Ltd.	0.121*	0.101*	-0.039	-0.064	-0.021	0.012	-0.009	0.021	-0.051	-0.201*	0.029	-0.039	0.042	0.04	0.124*	-0.074
Oriental Bank Of Commerce	0.171*	0.199*	-0.051	0.087	0.121*	0.036	-0.075	0.049	0.041	0.078	-0.1*	-0.003	0.042	0.023	0.071	-0.002
Pfizer Ltd.	-0.18*	0.104*	0.011	0.033	-0.086	0.045	0.018	0.042	-0.041	0.098*	-0.073	0.181*	-0.009	0.12*	-0.015	-0.072
Pidlite Industries Ltd.	-0.003	0.01	-0.059	-0.025	-0.002	0.019	-0.03	0.038	0.038	-0.049	0.011	-0.037	-0.082	-0.077	-0.014	0.065
Procter & Gamble Hygiene & Health Care Ltd.	-0.012	0.042	-0.068	-0.054	0.029	0.011	-0.049	-0.122*	-0.08	0.057	0.065	-0.006	-0.014	0.039	0.049	0.057
Punjab Tractors Ltd.	-0.158*	0.105*	0.185*	-0.08	0.104*	0.072	-0.075	0.018	-0.001	0.119*	-0.002	0.081	-0.003	-0.003	0.002	-0.219*
Ranbaxy Laboratories Ltd.	-0.001	-0.09	0.1*	-0.164*	0.131*	0.056	-0.158*	-0.08	-0.157*	-0.101*	0.097*	-0.059	-0.036	-0.057	-0.016	0.121*
Rashtriya Chemicals & Fertilizers Ltd.	0.077	-0.047	0	-0.155*	-0.113*	0.011	-0.157*	0.039	0.022	-0.196*	-0.006	0.086	-0.077	0.106*	0.116*	0.031
Raymond Ltd.	0.009	-0.107*	-0.121*	-0.189*	0.023	0.011	0.159*	-0.025	-0.018	-0.078	-0.11*	0.04	0.052	-0.069	0.141*	0.011
Reliance Capital Ltd.	0.02	0.045	0.024	0.052	-0.013	0.163*	-0.068	-0.074	0.042	-0.07	-0.027	-0.045	-0.146*	0	0.07	-0.148*
Reliance Energy Ltd.	-0.098*	0.015	-0.082	0.001	-0.037	0.224*	-0.079	-0.09	0.062	-0.02	-0.078	0.116*	-0.243*	-0.153*	0.08	-0.052
Reliance Industries Ltd.	0.047	-0.041	0.074	0.081	-0.075	-0.06	-0.056	0.041	0.006	0.048	0.04	0.035	-0.028	-0.033	-0.168*	0.013
Rolta India Ltd.	0.069	0.079	-0.052	-0.021	0.062	0.145*	-0.036	-0.091*	-0.095*	0.053	0.164*	0.052	-0.046	-0.16*	-0.137*	0.056
SKF India Ltd.	-0.026	0.045	-0.023	0.045	-0.006	0.032	0.069	-0.089	0.005	0.053	0.059	0.007	-0.037	0.022	0.068	-0.018
Satyam Computer Services Ltd.	0.053	0.129*	0.011	0.134*	-0.056	-0.15*	0.01	-0.037	-0.042	0.071	0.136*	0.16*	-0.02	0.043	-0.207*	-0.074
Shipping Corp. Of India Ltd.	0.033	0.05	0.249*	-0.014	-0.204*	-0.105*	-0.166*	-0.223*	-0.16*	-0.031	-0.041	0.035	0.025	0.083	0.274*	0.104*
Siemens Ltd.	-0.004	-0.22	0.015	0.087	0.014	-0.008	-0.041	-0.019	-0.088	0.033	0.02	-0.025	0.007	-0.04	0.02	-0.011
State Bank Of India	-0.158*	0.138*	-0.066	-0.143*	-0.006	0.029	-0.117*	0.119*	-0.106*	0.046	-0.017	-0.106*	0.072	-0.034	0.043	-0.023
Steel Authority Of India Ltd.	0.093*	0.044	-0.09	-0.048	-0.063	0.079	-0.048	-0.046	-0.075	-0.174*	-0.078	0.04	0.161*	0.115*	0.027	0.062
Sterling Biotech Ltd.	0.046	-0.123*	-0.01	0.075	0.008	-0.097*	-0.039	0.062	-0.103*	-0.01	-0.077	-0.011	0.016	-0.02	-0.1*	-0.088*
Sterlite Industries (India) Ltd.	0.073	-0.003	-0.121*	-0.004	0.075	0.033	-0.043	-0.229*	0.022	0.012	-0.013	-0.014	-0.045	-0.083*	-0.014	0.017
Sun Pharmaceutical Inds. Ltd.	0.077	-0.068	-0.102*	-0.068	0.049	-0.006	-0.258*	0.033	0	-0.085	0.063	-0.117*	-0.084	-0.029	0.077	0.134*
TVS Motor Co. Ltd.	0.028	0.033	0.052	-0.083	0.104*	-0.075	-0.07	-0.028	-0.009	0.023	-0.076	0.01	-0.057	0.031	0.023	0.018
Tamil Nadu Newsprint & Papers Ltd.	0.125*	-0.107*	-0.052	-0.062	-0.066	-0.041	-0.122*	-0.133*	0.039	-0.046	-0.011	-0.118*	-0.076	-0.007	0.123*	-0.012
Tata Chemicals Ltd.	-0.097*	0.005	0.107*	-0.162*	0.103*	0.07	-0.085	0.183*	0.031	-0.047	0.033	-0.067	0.035	0.081	-0.023	0.188*
Tata Elxsi Ltd.	-0.071	-0.016	-0.065	0.021	-0.042	0.083	-0.183*	-0.017	0.035	-0.073	0.12*	0.063	-0.135*	0.074	0.003	0.016
Tata Motors Ltd.	0.081	0.035	0.122*	-0.118*	0.001	0.071	-0.152*	0.039	0.094*	-0.08	-0.025	-0.004	-0.097*	-0.087	-0.002	0.017
Tata Power Co. Ltd.	-0.03	-0.106*	-0.039	-0.167*	0.092*	0.183*	-0.076	-0.041	-0.139*	-0.002	0.113*	0.069	-0.007	-0.064	-0.15*	0.019
Tata Steel Ltd.	0.012	0.053	-0.009	-0.224*	0.017	-0.01	-0.002	-0.106*	-0.048	-0.181*	-0.008	0.04	0.029	0.096*	-0.066	0.078
Tata Tea Ltd.	0.01	-0.05	0.096*	-0.081	-0.001	0.117*	-0.082	-0.015	0.022	-0.009	0.141*	0.014	0.005	-0.076	-0.02	0.015
Thermax Ltd.	0.027	-0.181*	-0.076	0.09	0.019	0.035	-0.003	-0.03	-0.051	-0.038	0.064	-0.014	-0.013	-0.091*	0.036	0.076
Titan Industries Ltd.	-0.1	-0.002	-0.066	0.067	0.056	0.095*	-0.19*	-0.052	0.119*	-0.063	0.009	0.034	0.006	0.087	-0.056	-0.022
Torrent Pharmaceuticals Ltd.	0.116*	0.052	-0.003	-0.016	0.018	-0.022	-0.167*	-0.14*	-0.108*	0.035	0.051	0.037	-0.081	-0.113*	-0.011	-0.043
United Phosphorus Ltd.	-0.018	0.016	-0.021	-0.025	0.052	0.039	0.102*	-0.013	0.008	-0.054	-0.04	0.049	-0.005	-0.066	-0.026	0.036
Videsh Sanchar Ngam Ltd.	-0.029	-0.032	0.062	0.033	0.062	0.096*	0.029	-0.082	0.067	-0.064	-0.114*	-0.081	0.062	0.015	0.048	0.013

Table 1: Serial Correlation Coefficients with Lags 1-16 for Sample Stocks During The Study Period, 1998- 2007

* Significant At Two Times Standard Error

A perusal of the result reported in the table 1, reveal that out of a total of 2432 auto correlation coefficients, 680 (about 35.7 %) were found to be significant, which are more than twice their computed standard errors. However, it must be noted that as the time period

separating the successive pairs of observations increases, i.e. as the lag is increased, correlation is likely to fade out. Thus, the coefficient to watch is the first order coefficient correlating the successive terms e_t and e_{t-1} . A look at table 1 indicate that of the 152 first order coefficients as many as 48 first order coefficient was found to be significant at two times the standard error. The largest of these coefficients was 0.293 for National Fertilizers Ltd. It also appeared from the table that all the coefficients for individual companies were small in absolute value. A surprising feature of these results was that out of 680 significant cases, 370 have negative auto correlation. It implies that the share's current price change is negatively correlated to that of its previous price change, thereby, indicating a widespread existence of bearish forces in the Indian stock market during the study period.

The result is thus inconsistent with the random walk hypothesis and suggests the existence of pattern in price movement. The magnitude of significant correlation is however quite small in absolute value. Hence 'dependence' of such a small magnitude, from a practical point of view is not much important for the investors in designing profitable trading strategy. Thus, one would generally expect lagged coefficients not to be significantly different from zero, if price changes are subject to random walk. However, the results reported in this study contradict this phenomenon as several lagged coefficients were found to be statistically significant. Moreover, excessive speculation, rampant insider trading, imperfections inflow of information, inadequate accounting and auditing standards like may affect the pricing mechanism on the Indian stock exchanges in a manner that may give rise to deviations from the random walk model. The result of serial correlation coefficient with the number of stocks with coefficient less than two times the standard error, number of stocks with negative significant coefficient values and the number of stocks with coefficient greater than twice the standard error is represented in table 4.4 in a summarized form:

Lags	Number of stocks with coefficient <2 S.E.	Number of stocks with negative significant coefficient values	Number of stocks with coefficient >2 S.E.
1	104	18	48
2	95	30	57
3	107	24	45
4	111	26	41
5	114	15	38
6	115	10	37
7	101	43	51
8	103	38	49
9	112	32	40
10	112	24	40
11	117	18	35
12	111	19	41
13	119	26	33
14	113	17	39
15	109	22	43
16	109	8	43
Total	1752*	370	680**

Table 2: Number of Significant Auto Correlation Coefficient Values

* 64.3 percent of total coefficients, ** 35.7 percent of total coefficients.

Note: This table is derived from result shown in Table 1. The percentage is obtained from the total coefficient as base.

An investigation of these significant serial correlations which are summarized in table 2 reveals that 48 out of 152 companies have a significant correlation coefficient at lag $k=1$. This indicates that there is serial dependence among the month to month stock price changes in these stocks. With regard to higher – order coefficients, 57 companies have significant coefficients at lag $k= 2$ and 43 at lag $k=16$. In this way, there are significant autocorrelation coefficients at all lags. This suggests that not only successive price changes are related but distant changes also exhibited same association. The presence of non- zero auto correlation coefficients in the share price series suggest that there may be some relationship between the past prices and the present prices. A cursory look at table 2 shows that about 36 percent coefficients are significant. It doesn't support the random walk. But approximately 64 percent results show the insignificant coefficient which, indicates that share prices are not serially correlated, they are independent and are supported to random walk. This may imply that even though the monthly share price series are random and independent due to less number of significant coefficients, but some sort of common periodic cycle may exist between the series. The results thus manifest mixed price behavior of the sample stocks. Taken together, it suggests that there is no departure from the random walk hypothesis. It should be emphasized, however, that while a quantitatively some serial correlation coefficient could be highly significant statistically; it may imply dependence that has limited economic significance. Thus, the serial dependence displayed by some of the individual companies can hardly be used for predicting the future course in a meaning full manner. This is because the proportion of variance in current price changes explained by past price changes is in general quite small.

Hence, from the point of view of investors, dependence of such a low order may not be enough for continuously earning extra returns by forecasting the security prices. Thus, the existence of quantitatively small auto correlation in financial markets doesn't necessarily imply market inefficiencies which emphasizes the possibility of making abnormal profit. In this way, the serial correlation result also

does not provide any evidence against the market efficiency. This is in sharp contrast with the findings of some earlier studies. For instance, Kulkarni (1978), Barua and Raghunathan (1986), Chaudhari (1991), Gupta and Gupta (1997) and Mitra (2000) found a serial correlation coefficient for individual shares to be generally statistically significant. On the other hand, there are many studies in India which supported the present study as Kendall (1953), Fama (1965) and King (1966) studied the behaviour of stock prices by using serial correlation technique. These studies found no evidence of serial dependence in stock prices and the security prices were random.

7. Resume

It concludes that successive price changes were independent of the previous month price changes. Although, a few lower order serial correlation coefficients of monthly price changes disclosed some departure from random walk hypothesis. In this way investors may detect patterns in those companies where random walk hypothesis has been violated. But the question of whether they would be able to earn abnormal returns, once transaction cost is considered, remains open and to be answered by further filter studies. The results of quantitative small serial dependence documented in this study might not represent for profitable trading strategies but might instead be due to other factors, such as thin trading in significantly serially correlated shares, and the presence of time varying risk premia (Ferson and Harvey 1991). It is also suggested that government intervention policies may cause stock price changes to be positively correlated (Liu and He, 1991). Moreover, there has certain concern over the interpretation of autocorrelation in emerging markets. In effect, the capital markets in India over the last decade observed large price swings in some periods. It is possible that autocorrelations are indicators of these extreme priced changes of either signs during this unusual period. However, the market returns were not found to be exactly normally distributed which means that the serial correlation test based on normality assumption may not be perfectly appropriate. Hence, the Indian stock market is considered informationally efficient in its weak form.

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