DAY-OF-THE-WEEK EFFECT ON STOCK RETURNS IN INDIA: EFFECT OF ECONOMIC REFORMS

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It is well known that India initiated major market-oriented and liberalized economic policies since 1992 although Indian capital markets began to reorganize itself a little earlier in the late eighties. In the wake of these reforms, especially, in the capital markets, it seems worthwhile to examine whether there is any indication of change similar to those observed in developed capital markets. In this paper we examine this issue with respect to the day-of-the-week effect on daily returns on Sensitive Index of Bombay Stock Exchange spanning the period January 2, 1984 to May 14, 1996, by applying appropriate regression analysis along with residual-based diagnostic tests. Our findings suggest that there has indeed been a change in the day-of-the-week effect indicating partial similarity to those observed for developed capital markets.

INTRODUCTION

During the last decade Indian capital markets have shown a spectacular growth in terms of investor population, number of listed companies with various stock exchanges in India, capital raised from primary market etc. For instance, the number of listed companies was over 8000 with a market capitalization of Rs 4,53,000 crores as on November 1996; the capital raised from primary markets increased from Rs 8,298 crores in 1990 to Rs 22,096 crores in 1996-97. This phenomenal growth had necessitated the need to control and regulate the capital market and to protect interests of the investors. Accordingly, bold and far-reaching steps were initiated since the late eighties (e.g., the Securities and Exchange Board of India was set up in 1988) in order to achieve rapid economic growth and development, globalization and international competitiveness of Indian capital markets. It is widely known that such reforms were undertaken not only in the financial sector but also in other sectors of the economy with the aim towards pursuing market-oriented and liberalized economic policies. While the character of the Indian economic system began to change towards openness very slowly since the late eighties, the large-scale reforms were initiated from 1992 onwards.

In the wake of these economic reform policies in the Indian economy as a whole and the Indian capital markets in particular, the question that we examine in this paper is whether the behaviour of the Indian stock prices in the sense of day-of-the-week effect on returns has changed in the period of economic reforms since 1992 as compared to the pre-1992 period. The day-of-the-week effect refers to the existence of a pattern on the part of the stock returns[1] in the sense that these returns are linked to any particular day(s) of the week. Naturally, the day-of-the-week effect poses interesting buy and hold strategy issues for the potential investors, and hence studying the presence of such effects on

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1. It may be noted that direct statistical analysis of stock prices is difficult since consecutive stock prices are likely to be highly correlated (cf. Taylor 1986), and the variance of the price increases with time. In other words, the unit root nature of stock prices poses problem for analysis with stock price data. It is for this reason that first differences of prices/logarithm of prices or what is better known as stock returns are instead used for empirical analysis. Moreover, it is "stock returns" rather than "prices" which "prices" which primarily motivate investors' decision making.

the returns of the stock markets are important and useful. Almost all the studies reported on this effect are concerned with the returns on the major stock markets in the developed economies, particularly in the USA. In these studies the researchers ((see for example, Cross (1973), French (1980), Keim and Stambaugh (1984) and Keim (1985)) have found that the average return on Fridays, the last trading day of the week, are significantly positive while those on Mondays, the first trading day of the week, are often negative. As stated by Lakonishok and Levi (1982), these findings on the prevalence of "day effect" in the stock returns is rather difficult to explain in terms of the two well-known hypotheses – calendar time hypothesis and trading time hypothesis (cf. French (1980))[2]. However, some researchers like Lakonishok and Levi (1982) and Rogalski (1984) have explained these findings in terms of differences in returns over trading and non-trading periods, and the delay between trading and settlements in stocks and in clearing cheques. Since these two day-of-the-week effects have been, in general, observed in all the studies concerning the stock prices of developed capital markets in advanced countries, it may be asserted that similar day-of-the-week effects are likely to be observed in emerging stock markets where capital market reforms and economic liberalization policies have been effectively initiated. It is with this view in mind that we study in this paper whether the behaviour of expected returns on Indian stock markets has changed in the period beginning 1992 as compared to pre-1992 period. If the findings are somewhat similar, i.e., mostly negative Monday effect and significant positive Friday effect, it may then be concluded that Indian stock prices show signs similar to those of developed capital markets in the wake of reforms.

Insofar as the day-of-the-week effect studies with Indian stock market returns are concerned, there is only one notable reference in the work of Poshakwale (1996), who studied this behaviour of expected returns on the daily National Index data of Bombay Stock Exchange covering the period 1984-94, and found evidence based on sample-based values of daily mean return and standard deviation of daily returns that average returns are different on each day of the week and that the returns achieved on Fridays are higher compared to other days of the week. But inferences based on values of such descriptive measures, without actually carrying out appropriate tests, are somewhat flawed, especially because the return data are most often highly autocorrelated. It appears that there is no other significant study on this particular behaviour of expected returns on Indian stock prices from consideration of either other standard stock prices/indices or application of more appropriate time-series based methodologies. In this paper we try to fill in this void to some extent in the sense that we study the change, if any, in the two periods – pre-1992 and post 1992[3] in the day-of-the-week effect on daily returns on Bombay Stock Exchange (BSE), Sensitive Index (SENSEX) by using linear regression analysis with dummy explanatory variables representing the effects of different days of week.

The paper is organized as follows. We describe the methodology in the next section, and the data and empirical findings in Section-III. The paper ends with some concluding remarks in Section-IV.

2.The calendar time hypothesis maintains that expected returns on Mondays would be higher in order to compensate for the longer holding period. The trading time views, on the other hand, states that expected returns are equal on different days of the week.

3.Post-1992 period i.e., sub-period-II, covers the period 2 April 1992 to 14 May 1996 whereas pre-1992 period i.e., sub-period-I, spans from 2 January 1984 to 30 March 1992.

II. METHODOLOGY: We have stated in the preceding section that the unit root nature of stock prices posses' serious problem, and hence stock returns are used for the purpose of empirical analysis. It is, therefore, appropriate that we first examine whether the returns are indeed stationary from consideration of trend. This is done by using Augmented Dickey-Fuller test of Said and Dickey (1984) and Phillips-Perron test (1988). We then consider the following regression model to study the day-of-the-week effect[4].

$$R_t = \alpha + \alpha_M D_{M_t} + \alpha_T D_{T_t} + \alpha_{Th} D_{Th_t} + \alpha_F D_{F_t} + \varepsilon_t, t = 1....n \quad .... (1)$$

Where, R_t is the return on *t-th* day calculated as $R_t = \ln P_t - \ln P_{t-1}$ is the stock price on *t-th* day, α is the intercept term representing the common effect as on Wednesday, D_M, D_T, D_{Th} and D_F denote the dummy variables for Monday, Tuesday, Thursday and Friday respectively, α_M α_T α_{Th} and α_F are the corresponding coefficients attached to these dummy variables indicating the differential effects with Wednesday and ε_t is the *t-th* disturbance term, which is assumed to be white noise. By definition, any dummy variable representing a particular day takes the value 1 for that day and 0 otherwise. Assuming that stock exchanges follow 5-day week working system, four dummies are considered for the regression model. All holiday weekdays are removed to eliminate any kind of undue effect on the actual seasonality of non-holidays.

The model is estimated using the ordinary least squares (OLS) method of estimation. Under the assumption of normality of the errors, t-ratios are obtained and the significance of the dummy variables tested. Significant positive/negative value of the coefficient for any particular day would mean that the average return on that day is significantly positive/negative as compared to the common day effect (i.e., Wednesday in our case), and hence conclusion may be drawn to the effect that the distribution of stock returns depends on the day(s) of the week.

As we are using regression analysis for our study, it is imperative that diagnostic tests on residuals be carried out to find whether errors are indeed white noise. This is done by computing, Ljung-Box test statistic (1978), which is given by

$$Q(k) = n(n+2) \sum_{j=1}^{k} r_j^2/(n-j)$$

Where r_j is the sample autocorrelation of lag *j* of OLS residuals and n is the total number of observations. This statistic follows a χ^2 distribution asymptotically with *k* degrees of freedom under the null of white noise errors.

In case the null hypothesis is rejected i.e., the errors show significant autocorrelations, the regression model is then respecified by incorporating lagged values of R_t i.e.,

$$R_t = \alpha + \alpha_M D_{M_t} + \alpha_T D_{T_t} + \alpha_{Th} D_{Th_t} + \alpha_F D_{F_t} + \sum_{j=1}^{q} \beta_j R_{t-j} + \varepsilon_t, \quad 1,2....n \quad ....(2)$$

Where β_j's are coefficients associated with the lagged values of the dependent variable and *q* is appropriately chosen so that ε_t's could indeed be assumed to be white noise. It may thus be noted that in this situation the regression equation in (1) would be considered to be a misspecified model and the inferences based on (1) may be inappropriate. As regards application of OLS to (2), it is well-known that OLS would in this case produce consistent and asymptotically efficient estimates.

III. EMPIRICAL RESULTS: In this section we discuss the empirical findings of this study. As

4. It may be noted that stock returns may be non-stationary from consideration of seasonality.

already stated, we have used the daily closing prices on Bombay Stock Exchange (BSE) as measured by BSE Sensitive Index (SENSEX). The data cover the period 2nd January 1984 to 14th May 1996. This period has been divided in two parts – pre-1992 and post-1992, more specifically, 2nd January 1984 – 30th March 1992 (called sub-period I) and 2nd April 1992 – 14th May, 1996 (called sub-period-II) – keeping in mind the purpose of this study viz. studying the movement of stock prices in the wake of movement towards economic liberalization. The returns have been calculated by using the first differences of the logarithms of SENSEX values. The analysed series thus represents the continuously compounded rate of return for holding the (aggregate) securities for one day.

In order to find if the return series is indeed stationary or not, we applied, as already stated, Augmented Dickey Fuller (ADF) test [cf. Said and Dickey (1984)] and Phillips-Perron (PP) test (1988). For both these tests a linear time trend was included to allow trend stationarity in the data. Both the tests soundly rejected the existence of unit root in favour of stationarity for each of the two sub-periods viz., 1984-92 and 1992-96 as well as for the entire period spanning 1984-96. For instance, ADF and PP test statistic values were found to be –15.186 and -1950.159 respectively for sub-period I. By comparing these values with the critical values as tabulated originally by Fuller (1976) and then extended by Guilkey and Schmidt (1989) and MacKinnon (1990), we find that the hypothesis of unit root is rejected by both the tests. Needless to mention that the coefficient associated with the time trend t turned out to be insignificant, the resulting t-statistic value for sub-period I being 1.059 and 0.181 by ADF and PP tests respectively.

The results of regression analysis are given in Tables-1 and 2. While the estimated coefficients along with their t-statistic values are given in Table-1, the results of diagnostic tests based on ordinary least squares (OLS) residuals are the contents of Table-2. We observe from results of regression (1) in Table-1 that for sub-period-I the coefficient associated with Tuesday is significant (only at five per cent level of significance) and negative in sign while all other day effects are insignificant. The findings of regression analysis with data of sub-period-II is quite different from those of sub-period-I in that here the coefficient associated with Tuesday is no longer statistically significant; instead only Friday coefficient is significant and positive in sign at both five per cent and one per cent levels of significance (one-sided alternative considered). This clearly indicates how the day-of-the-week effect on SENSEX returns has changed during post-1992 period as compared to pre-1992 period. We thus find that the behaviour of SENSEX after major reforms were initiated in sub-period II (i.e., April 2nd, 1992 till May 14th, 1996 for the data) is similar to that of the developed capital markets insofar as "positive Friday effect" is concerned. The other day-of-the-week effect observed in the developed markets viz., "negative Monday effect" is still not prevalent in Indian stock prices as exemplified with SENSEX data. A plausible explanation for this as well as the finding of "negative Tuesday effect" in the pre-1992 period is that during most part of eighties as also earlier the operational and information efficiency in Indian stock markets were rather insignificant and market behaved more as a customary response to officially regulated impulses rather than those based on free market stimuli. It is towards the end of eighties and thereafter that this character of Indian capital markets began to change along with some major changes in the Indian economic system as well. Our findings in the two sub-periods thus seem to suggest that in the wake of economic reforms in 1992 and onwards, the movement in the time-series of stock prices as given by SENSEX shows some sign of behaviour (in respect of day-of-the-week effect) similar to that observed in developed capital markets..

TABLE-1: DAY-TO-THE-WEEK EFFECT ON DAILY RETURNS ON SENSEX DATA

	Sub-Period-I (2nd January 1984-30th March 92)		**Sub-period-II** (2nd April 1992-14th May 96)		**Entire period** (2nd January 1984 to 14th May 96)	
Coefficient	Regression-1	Regression-2	Regression-1	Regression-2	Regression 1	Regression 2
α	0.012 (0.744)	0.015 (1.313)	-0.002 (-1.118)	-0.002 (-0.383)	0.007 (0.701)	0.010 (1.236)
α_M	-0.012 (-0.498)	0.002 (0.117)	0.002 (0.773)	0.002 (0.967)	-0.007 (-0.479)	0.002 (0.151)
α_T	-0.046 (-2.037)**	-0.034 (-1.988)**	0.001 (0.717)	0.002 (0.862)	-0.030 (-2.004)**	-0.021 (-1895)**
α_{Th}	-0.009 (-0.396)	0.001 (0.079)	0.001 (0.505)	0.002 (0.926)	-0.006 (-0.382)	-0.0002(-0.014)
α_F	0.015 (0.667)	0.003 (0.172)	0.005 (2.392)*	0.005 (2.412)*	0.011 (0.763)	-0.003(0.311)*
β		0.893 (36.487)*		0.184 (5.511)*		0.876 (44.346)*
β^{1}_{2}		-0.793 (-24.234)*		-0.088 (-2.578)*		-0.763 (-29.136)*
β_3		-0.702 (-18.535)*		0.117 (3.437)*		-0.662 (-21.991)*
β_4		-0.613 (-14.896)*		-0.133 (-3.884)*		-0.568 (-17.459)*
β_5		-0.528 (-12.236)*		0.169 (4.889)*		-0.482 (-14.161)*
β_6		-0.448 (-10.145)*		-0.043 (-1.239)		-0.403 (-11.592)*
β_7		-0.376 (-8.524)*		-0.077 (-2.226)**		-0.333 (-9.579)*
β_8		0.305 (7.069)*		0.020 (0.577)		0.267 (7.842)*
β_9		-0.237 (-5.741)*		0.039 (1.154)		-0.205 (-6.287)*
β_{10}		-0.175 (-4.628)*		-0.060 (-1.785)**		-0.151 (-5.023)*
β_{11}		-0.114 (-3.479)*		0.022 (0.662)		-0.097 (-3.709)*
β_{12}		-0.058 (-2.367)*		0.116 (3.562)*		-0.148 (-2.456)*

(t-ratio values are shown in parentheses)

* *indicates significance at both 5 per cent and 1 per cent levels:*

** *indicates significance at 5 per cent level only.*

TABLE: 2 LJUNG-BOX TEST STATISTIC (Q(K)) VALUES OF MODELS FOR SENSEX DATA

Q (k) value Based on	Lag (k) 1	3	6	9	12	15	18	21	24
Sub-Period I (2 January 1984 – 30 March 1992)									
Returns	417.0*	417.0*	417.0*	417.0*	417.0*	417.0*	417.0*	417.0*	417.0*
Regression 1 residuals	415.4*	415.4*	415.4*	415.5*	415.5*	415.5*	415.5*	415.6*	415.8*
Regression 2 residuals	0.012	2.237	1.469	4.673	12.320**	16.035**	16.092	16.099	16.341
Sub-Period II (2 April 1992 – 14 May 1996)									
Returns	16.6*	25.8*	40.3*	50.3*	62.8*	68.1*	70.9*	77.6*	81.9*
Regression 1 residuals	16.9*	26.2*	39.6*	49.6*	63.4*	69.1*	72.4*	79.3*	82.9*
Regression 2 residuals	0.042	0.128	0.165	1.527	1.925	9.275	11.999	14.786	18.479
Entire Period (2 January 1984 – 14 May 1996)									
Returns	636.0*	636.0*	636.0*	636.0*	636.0*	636.0*	636.0*	636.0*	636.0*
Regression 1 residuals	634.2*	634.2*	634.2*	634.2*	634.2*	634.2*	634.2*	634.4*	634.7*
Regression 2 residuals	0.008	0.161	1.050	3.521	9.773	13.224	13.454	13.476	13.749

** Indicates significance at both 5 per cent and 1 per cent levels*
*** Indicates significance at 5 per cent level only.*

We have already stated in Section II that diagnostic tests based on residuals are very important for proper inferences about a model. Towards this end we computed Ljung-Box Q(k) statistic values with OLS residuals of regression (1) for both the sub-periods and these are given in Table 2. However, we first computed the values of Ljung-Box statistic with the return data in order to find the extent of linear dependence amongst the observations. All computations of Q(k) statistic were done for lags up to 24, but we report for some lagged values only for reasons of brevity. We observe from this table that autocorrelations amongst the observations are highly significant in sub-period-I; the same is the conclusion with observations from sub-period II although Q(k) statistic values are now much reduced yet significant. Ljung-Box diagnostic test based on OLS residuals of regression (1) also produces the same conclusion viz., the residuals exhibit high autocorrelations – far from being white noise process as assumed in (1). Obviously, inferences based on this regression may then be misleading or improper.

To take account of the existing autocorrelations in the errors, we estimated regression equation in (2) in which q was chosen to be sufficiently large at 12 i.e., 12 lagged values of R_t were taken to be regressors in addition to the four dummies representing the day effects. It is evident from the results of regression (2) in Table-1 that the day-of-the-week effects viz., "negative Tuesday effect" in pre-1992 period and "positive Friday effect" in post-1992 period remain the same as in regression (1). As for the significance of the lagged coefficients we note that while all the 12 lagged coefficients are significant for the data from sub-period I, for sub-period-II only eight lagged coefficients are significant. The results of the diagnostic test based on OLS residuals from regression (2), as given in Table-2, show clearly that except for lagged values 12 and 15 for sub-period-I at five per cent level of significance, no significant autocorrelation exists in the residuals of regression (2) for both the sub-periods. Thus, we find that the appropriate regression equation for studying the day-of-the-week effect in the time series of SENSEX is given by regression (2) since the residuals of this regression turn out to be a white noise process.

Finally, before concluding, we mention that we have reported in Tables-1 and 2 the results of regression analysis based on the entire data set spanning the period 2nd January 1984 to 14th May 1996. It is clear that the findings in this case are exactly the same as those for sub-period-I. For instance, the conclusions regarding the prevalence of the day-of-the-week effect remain the same viz., significant (with negative sign) Tuesday effect and no other significant day effect. Hence, it may be concluded that the analysis with the entire data set, as used in this study, shows how conclusions on the day-of-the-week effect could be misleading if no a *priori* consideration to movement towards economic liberalization since 1992 is explicitly introduced in the analysis.

IV. CONCLUSION:

In this paper we have examined whether the behaviour of Indian stock prices in the sense of day-of-the-week effect on returns shows any sign of change during the period of major economic reforms beginning in 1992 as compared to the preceding period. We were motivated to this study from consideration of the fact that in the wake of more emphasis on reorganization of Indian capital markets since the late eighties and the subsequent thrust since 1992 towards major economic reforms in most sectors of the economy including financial sector, the behaviour of potential investors (for whom such effects pose interesting buy and hold strategies) might show some indication of change similar to those observed in developed capital markets. To study this "day effect" we have used the method of regression analysis with dummy variables and also carried out appropriate diagnostic checks based on least squares residuals. This important finding of this study is that the day-of-the-week effect has changed from Tuesday (with a negative sign) in pre-1992 period to Friday (with a positive sign) in post-1992 period, the later observation being the same as in developed capital markets. Since the other notable day-of-the-week effect observed in studies with return data on developed capital markets viz., "Monday (with a negative sign) effect," has not been found to be significant with returns on SENSEX, we may conclude that there is some evidence in Indian stock prices towards change in the day-of-the-week effect in the sense of it being partially similar to those observed for developed markets.

This finding should be useful to potential investors since it might help them in deciding their buy and hold strategy issues. Further, this result might suggest that further researches may be done to find if in the wake of economic reforms Indian stock prices are showing signs of change in terms of other important characteristic features of developed capital markets. In 1998, Basu and Morey have studied how reforms have changed the Indian stock prices in terms of obeying Fama's efficient market hypothesis, and found signs of greater efficiency after the beginning of economic reforms.

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