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An Investigation of the Day-of-the-Week Effect on Return and Volatility of NSE NIFTY

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Abstract

The present study has sought to investigate the issue of day-of-the-week effect in Indian stock market. Applying GARCH-M model on the daily NIFTY returns data, a comparative study has been conducted to observe whether there is any difference between two sub-periods that is the period representing before the introduction of the T+2 rolling settlement and that of representing after the introduction of such system respectively regarding day-of-the-week effect in Indian stock market. The findings of the study clearly indicate that there was day-of- the- week effect in the daily NIFTY return during the pre T+2 rolling settlement period. But, such effect vanishes after the introduction of T+2 rolling settlement. However, a significant day-of- the- week effect remains in conditional volatility in the second sub-periods particularly in case of Tuesday. Application of TGARCH model has confirmed the above results.

Keywords: Day-of-the-Week effect; Volatility; GARCH-M, Dummy Variable, T+2 Rolling Settlement

Introduction

In a well-functioning efficient market, one would expect that every day of the week should exhibit similar returns and volatility. According to Fama (1965), the proponent of Efficient Market Hypothesis, the expected return on a financial asset should be uniformly distributed across different units of time. However, researchers have documented several calendar anomalies in the stock returns. One of such anomalies is the day-of-the-week effect. The day-of-the-week effect indicates that returns are abnormally higher on some days of the week than on other days. Specifically, results derived from many empirical studies such as Fields (1931), French (1980), Gibbon and Hess (1981), Condoyanmi *et al.* (1987), Jaffe and Westerfield (1985), Dubois and Louvet (1996) have documented that the average return on Friday is abnormally high. On the contrary the returns on Monday are abnormally low. In addition, a significant negative mean return on Tuesday has been reported by Jaffe and Westerfield (1985), Condoyanmi *et al.* (1987), Balaban *et al.* (2001). Moreover, a negative Friday effect is identified in Germany and Austria (Balaban *et al.*, 2001). Some studies have tried to bring various explanations for the day-of- the-week effect. Lakonishok and Levi (1982) have argued that the day-of-the-week effect can be partly derived from the delay between trading and settlements in stocks and in clearing checks. Specifically, they have explained that the buyer will have eight calendar days before losing funds for stock purchases on a business day other than Friday based on rules of the U.S. stock market while for Friday purchases, the buyer will have ten calendar days. In other words, the buyer has two more days of interest earning. Therefore, the buyer would be willing to pay extra for stocks bought on Fridays. Another explanation for the daily seasonal anomaly has been proposed by Fortune (1991). According to him companies and governments tend to release good news during market trading when it is easily absorbed, and keep bad news

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until the close on Friday when investors can not react to the information until the Monday opening. Furthermore, according to Keim and Stambaugh (1984), measurement errors would partly contribute to the weekend effect. They have hypothesised that the low Monday returns could result from positive "errors" in prices on Friday. However, some recent studies have put question regarding these explanations (Chen *et al.*, 2001; Oguzsoy and Guven, 2003).

A considerable number of studies have not found any evidence in favour of day-of-the-week effect. Brooks and Persand (2001) find no evidence to support the presence of day-of-the-week effect in South Korean market.

Kohers *et al.* (2004) have found that the day-of-the-week effect has disappeared in most developed stock-markets.

However, according to Boudreaux (1995), if these anomalies exist in stock markets there would be possibility of earning above normal profit. The discovery of these anomalies thus shed doubt on the validity of the Efficient Market Hypothesis.

The Indian stock markets would be an interesting case in this context. As all are aware that T+2 rolling settlement came into vogue on 3rd April, 2003. Present study in this context has attempted to compare the issue of day-of-the week effect in both daily return and volatility in Indian stock market represented by NSE NIFTY before and after the introduction of T+2 rolling settlement. It could be expected that with the introduction of T+2 rolling settlement the delay between trading and settlement will be reduced considerably and any such anomaly would also be reduced.

Literature Review

There is no dearth of studies regarding this subject. A few studies have already been mentioned in the introduction. Some other important studies may be mentioned in the following lines.

Studies Relating to Foreign Markets

Cross (1973) is one of the first researchers to address the problem of returns disparities among weekdays. He has examined price changes for the S&P 500 Composite Index for the period 1953 through 1970. He has found stock prices to have risen most often on Fridays and least often on Mondays. Moreover, he has reported that Monday returns to have been dependent on the performance of the previous Friday.

French (1980) has examined the S&P 500 index returns over the period 1953 through 1977. He has reported significant negative Monday returns during his study period. In addition, returns have been found significantly positive from Wednesday through Friday.

Jaffe and Westerfield (1985) have found a day-of-the-week effect in the equity markets of the United Kingdom, Canada, Japan, and Australia. According to them, all of the aforementioned equity markets have negative Monday returns and high returns on the last trading day of the week. They have also reported that in Japan and Australia, the lowest mean returns have occurred on Tuesday.

Lakonishok and Smidt (1988) have examined 90 years (1897–1986) of weekday returns for the Dow Jones Industrial Average. They have also found Monday returns to have been significantly negative for the entire sample period and for seven out of nine sub-periods.

Brooks and Persand (2001) have investigated this very issue in five Southeast Asian stock markets and have found evidence of a day-of-the-week effect in Thailand, Malaysia and Taiwan. Monday returns have been found significantly positive for Thailand and Malaysia. Moreover, significantly negative returns on Tuesday have also been reported.

Hui (2005) using non parametric test, has examined day-of- the- week effect for four Asian Pacific markets and two developed markets. He has established that Hong Kong, Taiwan and Singapore has had higher average returns on Fridays and lower average returns on Mondays but the United States, Japan and South Korea has showed a mixed pattern. In the overall, it is only in Singapore where a significant day of the week effect has been observed.

Basher and Sadorsky (2006) using both unconditional and conditional risk analysis have examined this issue for 21 emerging markets. They have found no significant day of the week effect for the majority of emerging markets studied except the Philippines, Pakistan and Taiwan, which have exhibited day of the week after adjusting for market risk.

Tachiwoun (2010) has given an analysis of day of the week effect of the West African regional stock market for the period 1998 -2007. He has observed lowest returns on Tuesdays and Wednesdays and highest returns on Fridays.

Study carried out by Ariss, Rezvanian and Mehdian (2011) has focused on the Gulf Cooperation Council market which includes 7 indices. These markets start their trading day on a Saturday and end on a Wednesday and therefore the typical Friday effect has been called the Wednesday effect by the authors. Wednesday reveals significantly higher returns than any other day of the week. Even though the results are similar to previous research conducted on the western regions, the authors has argued that the reason for the day of the week effect was not straight forward, because there is no short selling allowed and the settlement period in the Gulf Cooperation Council market is much shorter than in the western regions. So they have concluded that the anomaly could be due to investor optimism and thereby a will to buy stocks just before the weekend.

Diaconasu, Mehdian and Stoica (2012) have researched the-day-of-the effect on Bucharest Stock Exchange during 2000 and 2011 and have observed the presence of Thursday effect but have not found the presence of the Monday effect during the study period.

Studies Relating to Indian Markets

Poshakwale (1996) has used daily closing prices of Bombay Stock Exchange Index from 2nd January 1987 to 31st October 1994 to investigate the possibility of day-of-the- week effect. The results provided evidence of day-of-the- week effect in the BSE returns.

Amanulla and Thiripalraju (2001) have reported Wednesday and Tuesday effect in the BSE when there was modified and revised modified carry-forward transactions used to be in the market. Moreover, this study has also explored a positive Monday and negative Friday effect in the market.

In his study Sarma (2004) has tried to explore whether there was any day-of-the week effect in the daily returns in SENSEX, NATEX and BSE 200 during the study period from 1st January 1996 to 10th August 2002. The results of Kruskal-Wallis (H) test do not indicate any such effect in the daily returns series.

Kaur (2004) has also not found any day-of-the week effect in the returns of SENSEX and Nifty during the study period between January 1993 to March 2003 and November 1995 to March 2003 respectively for two indices.

Nath and Dalvi (2005) have explored that before the introduction of rolling settlement January 2002 there was significant Monday and Friday effect in Nifty daily returns. After the introduction of this, Friday became significant.

Chander *et al.* (2008) have scrutinized the very issue in case of the daily returns calculated from BSE SENSEX, BSE 100, NIFTY and S&P CNX 500. The study has specifically reported low Friday returns in the pre-rolling settlement period. On the whole significant day-of-the week effects in the returns have been reported.

Patel and Patel (2011) have investigated the presence of day-of-the week effect in the returns of BSE SENSEX during the period from 2001 to 2010. The result shows there was no such anomaly during the study period.

Nageswari *et al.* (2011) taking daily data of S&P CNX NIFTY and S&P CNX 500 index for the period between 1st April 2002 and 31st December 2010 have conducted a study to investigate the issue. They have used both the Kruskal-Wallis (H) test and dummy variable OLS regression. The results of both the techniques have revealed the absence of day-of-the week effect in the market.

Deepak and Viswanath (2012) have investigated whether calendar anomalies were present in NSE NIFTY during the period from 1990 to 2011. Daily, weekly and monthly returns have been compared applying different mean tests, Kruskal-Wallis (H) test and Mann-Whitney (U) test. Moreover OLS regression and GARCH model have also been applied to uncover any seasonal anomaly in the market. The study has found significant day-of-the week effect in the market during the study period.

Data and Methodology

Data

The data used in this study is daily NSE NIFTY return for the periods from July 03, 1997 to April 02, 2003 (a total of 1358 observations), termed as pre T+2 rolling settlement period and from April 03, 2003 to December 28, 2012 (a total of 2417 observations), termed as the post T+2 rolling settlement period. The data have been obtained and downloaded from the website www.finance-yahoo.com. Daily Market Returns (R_t) have been computed as follows:

$R_t = \ln(I_t) - \ln(I_{t-1})$

where, ln denotes natural logarithm

I_t is the closing index value at day 't'

I_{t-1} is the closing index value at day before 't'

Methodology

In order to effectively determine the presence of the day- of- the -week effect in daily returns and volatility and taking into account the time varying property of volatilities, the second GARCH-M model as proposed by Kiymaz and Berument (2003) has been used:

$$R_t = \alpha_0 + \alpha_M M_t + \alpha_T T_t + \alpha_H H_t + a_F F_F + \sum_{i=1}^{n} \alpha_i R_{t-i} + \lambda\sigma_t + \varepsilon_{i,t} \quad \text{(Eq. 1)}$$

$$\sigma_t^2 = V_C + V_M M_t + V_T T_t + V_H H_t + V_F F_F + V_{1a}\varepsilon_{t-1}^2 + V_{1b}\sigma_{t-1}^2 \quad \text{(Eq. 2)}$$

where R_t represents returns on a selected index, M_t, T_t, H_t, and F_t are the dummy variables for Monday, Tuesday, Thursday, and Friday at time t. We do not include a dummy variable for Wednesday in order to avoid the dummy variable trap. λ is a measure of the risk premium. If λ is positive, then risk averse agents must be compensated to accept higher risk. To solve the possible problem of autocorrelation lagged values of returns have also been incorporated. This model incorporates the day of the week effect for both the return and volatility equations by using the Modified-GARCH (1,1) specification.

For non negativity,

$V_C \geq 0$, $V_{1a} \geq 0$, $V_{1b} \geq 0$ and $V_{1a} + V_{1b} < 1$.

If coefficients of dummy variable are significant then there is day-of-the-week effect in returns or volatility or both.

In order to determine the day of the week effect, one must test whether the variables for all four days are jointly zero. However, due to the high degree of non-linearity of the model and the high correlation among the day of the week dummy variables, following Kiymaz and Berument (2003), the day of the week effect if any day's return (or volatility) is different from any other day (here Wednesday), rather than every single day's return (or volatility) being equal to that of the others have been tested.

Empirical Results

Descriptive Statistics

The descriptive statistics of daily market returns have been presented in the Table 1.

Table 1: Descriptive Statistics of Daily NIFTY Returns

Panel A: Pre-T+2 Rolling Settlement Period

	All Days	Monday	Tuesday	Wednesday	Thursday	Friday
Mean	-0.000149	-0.00123	-0.001150	0.004569	-0.000484	-0.001791
Median	0.000115	-0.00047	0.000175	0.003666	-0.000412	-0.001900
Standard Deviation	0.017181	0.020062	0.016044	0.016887	0.014968	0.016874
Kurtosis	6.265323	6.816376	7.049047	4.503073	4.132900	5.847522
Skewness	-0.147116	-0.559436	-0.933248	0.584938	0.111438	0.372413
Minimum	-0.1062	-0.1062	-0.08196	-0.04109	-0.04761	-0.055
Maximum	0.076276	0.076276	0.047815	0.07042	0.053848	0.075394
Jarque-Bera	608.2089	177.2777	223.6341	41.56897	15.66435	94.57268
Probability	0	0	0	0	0	0
Observations	1358	269	270	275	282	262

Panel B: Post-T+2 Rolling Settlement Period

	All Days	Monday	Tuesday	Wednesday	Thursday	Friday
Mean	0.000735	0.000520	0.000842	0.001126	0.000124	0.001062
Median	0.001441	0.001775	0.001093	0.001553	0.001685	0.001282
Standard Deviation	0.019913	0.015053	0.015246	0.015229	0.017704	0.019913
Kurtosis	11.69064	16.58046	6.886791	5.276768	5.167783	10.91386
Skewness	-0.264125	0.089908	0.115178	-0.127419	-0.390276	-0.987283
Minimum	-0.13053862	-0.13054	-0.0689	-0.0638	-0.07013	-0.13014
Maximum	0.163343151	0.163343	0.079691	0.06022	0.061143	0.067574
Jarque-Bera	7634.321	3719.968	307.6259	105.8471	106.3921	1333.333
Probability	0	0	0	0	0	0
Observations	2417	484	487	484	481	481

It could be seen that the returns during the pre T+2 rolling settlement period varies between -0.1062 to 0.076276 and that of the post T+2 rolling settlement period varies between -0.13053862 to 0.163343151. So a wide range of fluctuation in daily returns could be witnessed. The mean returns during the two study period are -0.000149 and 0.000735 which are very near to zero. Skewness is negative indicating a relatively long left tail compared to the right one. Kurtosis in excess of 3 indicating heavy tails and the distribution is leptokurtic. Moreover, a highly significant large JB statistic confirms that the return series is not normally distributed.

Unit Root Test

The time series data used in the empirical study must be stationary. Mean, variance and co-variance of a stationary time series data do not change with the time sift. If the data is non-stationary then regression results using such data would be spurious, because the usual 't' test would not be applicable to test the significance of coefficients.

To test the stationarity the unit root test is applied on the time series return data. In this regard the Phillips-Perron Unit Root Test is used. In Phillips-Perron Test non-parametric statistical methods are used to take care of the serial correlation in the error term (μ_t) of the following equation:

$$\Delta Y_t = \alpha + \delta Y_{t-1} + \mu_t$$

where Y_t is the time series data under consideration.

The test is based on the null hypothesis H_0 : Y_t is not I(0). If the absolute PP statistics are greater than the critical value then Y_t is stationary.

The PP test result is reported in the Table 2. The computed values of PP for two sub-periods are -35.08 and -46.14 respectively which are far greater than the critical value of -3.4333 at 1% significant level, if absolute value is concerned. Therefore, it appears that the variable used in this study is stationary at its level.

Table 2: Unit Root Test Results

Variable	Computed PP	
Daily NIFTY Return Series	Pre-T+2 period	Post-T+2 period
	-35.08 *	-46.14*

* Significant at 1% level

Auto-Correlation Test

To judge the auto correlation of the time series returns data under consideration Box-Pierce Q statistic in the following form has been used.

$$Q = n\sum_{k=1}^{m} \rho_k^2 \sim x^2 m$$

where n=sample size and m= lag length. Since the present study uses daily data a lag length up to 22 has been considered. The reason behind this is that there could be at most 22 trading days in a 30 days month.

If the computed Q statistic is significant then it indicates the presence of autocorrelation.

The Q statistics of return time series data for lag 10 and lag 22 have been reported in Table 3.

Table 3: Box-Pierce Q Statistics of Return Time Series Data

Panel A: Pre-T+2 Rolling Settlement Period

Lag	Q statistic	Probability
10	18.411	0.05*
22	37.39	0.03*

* Significant at 5% level

Panel B: Post-T+2 Rolling Settlement Period

Lag	Q statistic	Probability
10	30.083	0.001*
22	57.890	0.000*

* Significant at 1% level

From Table 3, it is clear that Q statistics are highly significant. Hence, the return series is serially correlated in both the sub-periods.

Results of GARCH-M Model

The estimated results of equation 1 and 2 have been presented in Table 4.

Table 4: Results of GARCH-M Model

Panel A: Pre-T+2 Rolling Settlement Period

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Equation…….1(Mean Equation)				
λ	0.142931	0.096742	1.477450	0.1396
α_0	0.000540	0.001708	0.316269	0.7518
α_M	-0.003108	0.001207	-2.576066	0.0100*
α_T	-0.002863	0.001210	-2.366323	0.0180*
α_H	-0.001509	0.001176	-1.282874	0.1995
α_M	-0.003248	0.001210	-2.684522	0.0073*
R_{t-1}	0.086731	0.029943	2.896546	0.0038*
Equation…..2 (Variance Equation)				
V_C	7.57E-05	8.58E-06	8.824600	0.0000*
V_{1a}	0.118774	0.015287	7.769804	0.0000*
V_{1b}	0.852769	0.013168	64.75830	0.0000*
V_M	-4.56E-06	1.40E-05	-0.326508	0.7440
V_T	-0.000146	1.15E-05	-12.69441	0.0000*
V_H	-9.81E-05	2.10E-05	-4.679685	0.0000*
V_F	-7.52E-05	1.57E-05	-4.803570	0.0000*

* Significant at 1% level

Panel B: Post-T+2 Rolling Settlement Period

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Equation…….1(Mean Equation)				
λ	0.006638	0.065921	0.100694	0.9198
α_0	0.001152	0.000918	1.255326	0.2094
α_M	0.000290	0.000820	0.353826	0.7235
α_T	0.000121	0.000714	0.168979	0.8658
α_H	-0.000109	0.000753	-0.144769	0.8849
α_F	0.000305	0.000806	0.378414	0.7051
R_{t-1}	0.064471	0.022286	2.892844	0.0038*
Equation…..2 (Variance Equation)				
V_C	1.18E-05	7.38E-06	1.599964	0.1096
V_{1a}	0.120231	0.009726	12.36244	0.0000*
V_{1b}	0.862671	0.010393	83.00136	0.0000*
V_M	6.00E-07	1.23E-05	0.048816	0.9611
V_T	-4.00E-05	1.21E-05	-3.314648	0.0009*
V_H	-3.21E-07	1.23E-05	-0.026170	0.9791
V_F	7.50E-06	1.16E-05	0.646713	0.5178

* Significant at 1% level

From the Panel A of Table 4 it could be seen that the coefficients of dummy variables of Monday, Tuesday and Friday in the equation 1 are significant. So it could be said that there was day-of-the week effect in the daily NIFTY returns during the pre-T+2 rolling settlement period.

From the Panel B of Table 4 it is clear that none of the coefficients of dummy variables in the equation 1 is significant. So it could be safely said that such day-of-the week effect in the daily NIFTY returns has been vanished after the introduction of the T+2 rolling settlement.

It is noteworthy that λ is not significant in equation 1 in case of both the sub-periods. This result would indicate that positive risk-return relationship does not hold during this period. In other words investors do not want to bear extra risk even for a greater compensation.

The estimated volatility coefficients for the constant terms, as well as the error term and GARCH term, are positive and statistically significant. This finding satisfies the non-negativity of the conditional variances. V_{1a} + V_{1b} = 0.97 and 0.98 respectively for the two sub-periods which are approaching 1.00. Hence, shocks to volatility persist over time.

In the volatility equation the coefficients of Tuesday, Thursday and Friday dummy variables are significant in the pre T+2 rolling settlement period. However, only the Tuesday dummy variable is negative and significant in the post T+2 rolling settlement period. Hence, we confirm that the day of the week effect is still present in the variance (volatility or risk) equation. Goswami and Anshuman (2000) have observed evidences of a significantly negative Tuesday returns at the Indian capital market. Kiymaz and Berument (2003) have also reported some significant negative coefficients in dummy variables in the variance equation.

Condoyanni *et al.* (1987) have used the time-zone theory to explain the Tuesday effect. They pointed out that the information on US equity markets may affect to the other markets after US market has closed on Mondays. Therefore, they assume that the negative Tuesday effect in some countries is a reflection of the US Monday effect. According to Kiymaz and Berument (2003) the variances are positive but some variables with corresponding negative coefficients may force the conditional variance to take on negative values.

Table 5: Box-Pierce Q Statistics of Squared Residuals

Panel A: Pre-T+2 Rolling Settlement Period

Lag	AC	PAC	Q-Stat	Prob
1	0.011	0.011	0.1713	
2	0.012	0.012	0.3613	0.548
3	0.001	0.001	0.3632	0.834
4	-0.039	-0.039	2.4010	0.493
5	-0.012	-0.012	2.6110	0.625
6	-0.013	-0.012	2.8545	0.722
7	0.010	0.011	2.9954	0.809
8	-0.021	-0.022	3.5772	0.827
9	-0.034	-0.035	5.1426	0.742
10	0.001	0.001	5.1448	0.822
11	0.002	0.003	5.1508	0.881
12	-0.007	-0.008	5.2127	0.920
13	-0.022	-0.025	5.8741	0.922
14	-0.001	-0.001	5.8746	0.951
15	-0.024	-0.024	6.6964	0.946
16	-0.002	-0.001	6.7007	0.965
17	0.035	0.033	8.4296	0.935
18	-0.008	-0.011	8.5157	0.954
19	-0.022	-0.025	9.1535	0.956
20	-0.026	-0.026	10.058	0.951
21	0.014	0.015	10.317	0.962
22	-0.004	-0.005	10.341	0.974

To see whether any ARCH effect is still present or not Q statistic on the squared residuals of the GARCH-M model has been calculated and the result has been reported in Table 5.

Panel B: Post-T+2 Rolling Settlement Period

Lag	AC	PAC	Q-Stat	Prob
1	0.009	0.009	0.1782	
2	-0.010	-0.010	0.4025	0.526
3	0.024	0.024	1.7628	0.414
4	0.028	0.027	3.6151	0.306
5	-0.008	-0.008	3.7857	0.436
6	-0.015	-0.015	4.3252	0.504
7	-0.017	-0.018	5.0256	0.541
8	-0.018	-0.018	5.7913	0.564
9	-0.024	-0.023	7.2069	0.514
10	0.024	0.025	8.5592	0.479
11	-0.022	-0.021	9.7406	0.464
12	-0.018	-0.015	10.497	0.486
13	0.033	0.032	13.085	0.363
14	0.008	0.005	13.229	0.430
15	0.008	0.009	13.367	0.498
16	0.006	0.004	13.448	0.568
17	-0.024	-0.027	14.823	0.538
18	-0.013	-0.014	15.234	0.579
19	0.003	0.003	15.258	0.644
20	0.004	0.004	15.306	0.703
21	0.012	0.017	15.684	0.736
22	0.012	0.015	16.052	0.767

Since none of the Q statistic at any lag is significant so no ARCH effect is left.

A test for the presence of ARCH in the residuals has also been calculated by regressing the squared residuals on a constant and p lags, here p has been taken as 5 (Engle, 1982)

$$\varepsilon_t^2 = \beta_0 + \left(\sum_{s=1}^{p} \beta_s \varepsilon_{t-s}^2 \right) + v_t \qquad \text{(Eq. 3)}$$

The F-statistic is an omitted variable test for the joint significance of all lagged squared residuals. The Observed*R-squared statistic is Engle's LM test statistic, computed as the number of observations times the from the test regression. The exact finite sample distribution of the F-statistic under H_0 is not known, but the LM test statistic is asymptotically distributed as a $x^2(p)$. If F-statistic and the LM statistic are found significant then there is ARCH effect. The results have been presented in Table 6.

Table 6: ARCH-LM test Results

Panel A: Pre-T+2 Rolling Settlement Period

Heteroskedasticity Test: ARCH				
F-statistic	0.516905	Prob. F(5,1346)		0.7637
Obs*R-squared (LM Statistic)	2.591070	Prob. Chi-Square(5)		0.7627
Test Equation:				
Dependent Variable: WGT_RESID^2				
Method: Least Squares				
Sample (adjusted): 7 1358				
Included observations: 1352 after adjustments				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	1.017400	0.084612	12.02423	0.0000
WGT_RESID^2(-1)	0.011041	0.027253	0.405132	0.6854
WGT_RESID^2(-2)	0.012363	0.027234	0.453964	0.6499
WGT_RESID^2(-3)	0.001128	0.027238	0.041409	0.9670
WGT_RESID^2(-4)	-0.038675	0.027230	-1.420270	0.1558
WGT_RESID^2(-5)	-0.011570	0.027249	-0.424609	0.6712
R-squared	0.001916	Mean dependent var		0.991835
Adjusted R-squared	-0.001791	S.D. dependent var		2.193976
S.E. of regression	2.195940	Akaike info criterion		4.415525
Sum squared resid	6490.617	Schwarz criterion		4.438644
Log likelihood	-2978.895	Hannan-Quinn criter.		4.424183
F-statistic	0.516905	Durbin-Watson stat		1.999784
Prob(F-statistic)	0.763655			

Panel B: Post-T+2 Rolling Settlement Period

Heteroskedasticity Test: ARCH				
F-statistic	0.776581	Prob. F(5,2405)		0.5665
Obs*R-squared (LM Statistic)	3.886319	Prob. Chi-Square(5)		0.5659
Test Equation: 3				
Dependent Variable: WGT_RESID^2				
Method: Least Squares				
Sample (adjusted): 7 2417				
Included observations: 2411 after adjustments				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	0.955296	0.060898	15.68691	0.0000
WGT_RESID^2(-1)	0.008563	0.020328	0.421231	0.6736
WGT_RESID^2(-2)	-0.009559	0.020321	-0.470394	0.6381
WGT_RESID^2(-3)	0.023841	0.020316	1.173468	0.2407
WGT_RESID^2(-4)	0.027932	0.020322	1.374460	0.1694
WGT_RESID^2(-5)	-0.008416	0.020330	-0.413970	0.6789
R-squared	0.001612	Mean dependent var		0.997738
Adjusted R-squared	-0.000464	S.D. dependent var		2.025824
S.E. of regression	2.026294	Akaike info criterion		4.252779
Sum squared resid	9874.610	Schwarz criterion		4.267183
Log likelihood	-5120.726	Hannan-Quinn criter.		4.258018
F-statistic	0.776581	Durbin-Watson stat		1.998941

From Table 6, it appears that both the *F*-statistic and the *LM*-statistic are insignificant, confirming the absence of any ARCH effect.

GARCH models enforce a symmetric response of volatility to positive and negative shocks. The conditional variance in equation (2) is a function of the magnitudes of the lagged residuals and not their signs (by squaring the lagged error in (2), the sign is lost). However, it has been observed that a negative shock to stock market return time series is likely to cause volatility to rise by more than a positive shock of the same magnitude, (Black, 1976).This is called the leverage effect.

Glosten, Jaganathan and Runkle (1993) introduced Threshold GARCH model (TGARCH) which is also known as GJR model which is an extension of GARCH with an additional term to account for possible asymmetries. Since, descriptive statistics in the study shows that returns are asymmetric in nature, TGARCH model has been applied to the data set to check whether any difference in above results could be observed or not. The conditional mean and variance equations can be re-represented applying TGARCH model as under:

$$R_t = \alpha_0 + \alpha_M M_t + \alpha_T T_t + \alpha_H H_t + \alpha_F F_F + \sum_{i=1}^{n} \alpha_i R_{t-i} + \varepsilon_{i,t} \quad \text{(Eq. 4)}$$

$$\sigma_t^2 = V_C + V_M M_t + V_T T_t + V_H H_t + V_F F_F + V_{1a}\varepsilon_{t-1}^2 + V_{1b}\sigma_{t-1}^2 + V_{1c}\varepsilon_{t-1}^2 I_{t-1} \quad \text{(Eq. 5)}$$

The results of the above equations have been reported in Table 7.

Table 7: Results of TGARCH Model

Panel A: Pre-T+2 Rolling Settlement Period

Variable	*Coefficient*	*Std. Error*	*z-Statistic*	*Prob.*
Equation…….4 (Mean Equation)				
α_0	0.002473	0.000996	2.482646	0.0130*
α_M	-0.003370	0.001223	-2.756251	0.0058*
α_T	-0.003845	0.001166	-3.299305	0.0010*
α_H	-0.001804	0.001183	-1.524863	0.1273
α_F	-0.003789	0.001225	-3.092208	0.0020*
R_{t-1}	0.095632	0.029790	3.210248	0.0013*
Equation…..5 (Variance Equation)				
V_C	8.98E-05	1.08E-05	8.310203	0.0000*
V_{1a}	0.062816	0.016524	3.801482	0.0001*
V_{1b}	0.828160	0.016447	50.35389	0.0000*
V_{1c}	0.140677	0.028350	4.962241	0.0000*
V_M	-9.42E-06	1.49E-05	-0.634037	0.5261
V_T	-0.000160	1.18E-05	-13.55689	0.0000*
V_H	-0.000117	1.89E-05	-6.166739	0.0000*
V_F	-8.90E-05	1.51E-05	-5.878878	0.0000*

* Significant at 1% level

Panel B: Post-T+2 Rolling Settlement Period

Variable	*Coefficient*	*Std. Error*	*z-Statistic*	*Prob.*
Equation…….4 (Mean Equation)				
α_0	0.000980	0.000563	1.739862	0.0819
α_M	0.000164	0.000834	0.196308	0.8444
α_T	-4.38E-05	0.000715	-0.061231	0.9512
α_H	-0.000279	0.000749	-0.371680	0.7101
α_F	4.00E-05	0.000797	0.050148	0.9600
R_{t-1}	0.075617	0.022731	3.326537	0.0009*
Equation…..5 (Variance Equation)				
V_C	1.46E-05	7.07E-06	2.058685	0.0395*
V_{1a}	0.044275	0.010086	4.389821	0.0000*
V_{1b}	0.857054	0.011081	77.34636	0.0000*
V_{1c}	0.141245	0.017764	7.951276	0.0000*
V_M	5.60E-06	1.23E-05	0.454040	0.6498
V_T	-4.36E-05	1.11E-05	-3.928725	0.0001*
V_H	-2.09E-06	1.15E-05	-0.181770	0.8558
V_F	2.80E-06	1.09E-05	0.256111	0.7979

* Significant at 1% level

It is very clear from Table 7 that the estimated results of TGARCH model are almost identical to that of GARCH model. In the volatility equation the coefficients of Tuesday, Thursday and Friday dummy variables are significant in the pre T+2 rolling settlement period. However, only the Tuesday dummy variable is negative and significant in the post T+2 rolling settlement period. One can check these results by applying other models under ARCH-GARCH class in future studies.

Conclusion

In an efficient market, it is expected that every day of the week should exhibit similar returns and volatility. However, many studies over the years have reported calendar anomalies in stock market returns. These anomalies can be listed briefly as the weekend effect, the day-of-the-week effect, and the January effect. In this context, the day-of-the-week effect indicates that returns are abnormally higher on some days of the week than on other days. Specifically, many empirical studies have documented that the average return on Monday was abnormally low while the average return on Friday was abnormally high. Present study in this context has investigated this very issue in case of daily NSE NIFTY return covering the periods from July 3, 1997 to April 2, 2003, termed as pre T+2 rolling settlement period and from April 3, 2003 to December 28, 2012, termed as the post T+2 rolling settlement period. Using GARCH-M model as used by Kiymaz and Berument (2003) present study in this context has attempted to compare the issue of day-of-the week effect in both daily return and volatility in Indian stock market represented by NSE NIFTY before and after the introduction of T+2 rolling settlements to see whether such effect is still there or not.

The empirical results indicate that there was such effect in daily return before the introduction of T+2 rolling settlements. However, no such day-of-the-effect is present after the introduction of T+2 rolling settlement.

However, a negative significant Tuesday effect has been reported in conditional volatility even after the introduction of T+2 rolling settlements. There were significant Tuesday, Thursday and Friday effects in conditional volatility before the introduction of such system. The estimated results of TGARCH model also confirm the same.

Finally, to conclude it can be said that anomaly such as day-of-the-week is gradually diminishing from the market and the market is becoming more efficient in its weak form.

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