THE DAY OF THE WEEK EFFECT ON STOCK MARKET RETURNS AND VOLATILITY OF THE NATIONAL STOCK EXCHANGE

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This paper tries to analyse the day of the week effect on the volatility for the National Stock Exchange(NSE), Mumbai, using the daily data on the S&P CNX Nifty Index for the period from the 1st of January 1998 to the 31st of December 2003. The paper specifies a GARCH model on returns, introduces separate dummies for each day, and excludes one of the days to prevent getting into the dummy variable trap. The findings of this paper suggest that, although the returns vary across the days in the NSE, volatility of the stock market is not significantly affected by the day of the week phenomena.

I- Introduction

The day of the week effect is one of the most common calendar anomalies present in the financial markets. The day of the week effect is found not only in the stock markets of the developed economies like USA but also in those of many other nations. It is seen that the distribution of stock returns varies according to the day of the week. The average return on Monday is significantly smaller than that on any other day of the week. A plausible theoretical explanation is that the most unfavourable news for the markets usually comes over the weekends, causing most of the investors to sell their shares. The selling of shares causes a decline in the returns, and the decline is reflected in the returns on Monday. On the other hand, since Friday is the last day of trading during the week, it is believed that the investor has a feel-good effect, and shows a tendency rather to buy than sell shares, thus raising the net returns.

Any intelligent investor would not only be interested in the returns but also the risk associated with the returns. This risk or variance of returns is termed as "Volatility" of the returns. Thus, a rational investor would be keen to know whether the high returns that he earns from the market are associated with a high level of risk or volatility, and vice versa. Thus, investment decisions based on returns and volatility would become much more simpler if we could discern the pattern of the volatility in the stock returns. So, it seems important to know whether there are variations in

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the volatility of stock returns by day of the week or whether there is any association between a high (low) return and a corresponding high (low) return for a given day. Having this much information may allow investors to adjust their portfolios by taking into account the day of the week variations in volatility. Finding a pattern in volatility may be useful in two main ways. The pattern of predicted volatility can be used in hedging and speculation, and in calculating the value of certain assets specifically stock index options.

The day of the week regularity is not limited to the equity market, but it has also been seen in other financial markets including the futures market, Treasury bill market, and bond market. Research in this area has been pursued using time series of stock market variables through Generalised Autoregressive Conditional Heteroskedasticity(GARCH) model. The common point of all these studies in this area is that returns in the stock market are time varying and conditionally heteroskedastic.

The study investigates the day of the week effect on returns and volatility for the National Stock Exchange, by means of a GARCH model computed with daily data for the period 1998 - 2003. The rest of the article is divided into four sections: Section- II presents a brief survey of the literature, Section- III describes our methodology, Section- IV discuses empirical results, and Section- V concludes our findings.

II- A Survey of the Literature

In recent decades, the testing for market anomalies in stock returns has become an active field of research in empirical finance. Among the most well-known anomalies are the size effect, the January effect, and the day-of-the-week effect (Monday effect). Recent studies, examining data until the early 1990's, document the existence of a day of the week effect in major markets. Though testing for market anomalies often involves the use of several tests, it is a matter of fact that empirical studies often do not account for the multiplicity effect appropriately. The studies mentioned above focus on the mean return, but another way to investigate the return and the day of the week effect is the GARCH model. There are lots of specifications for this model in the literature. Some empirical studies have recently investigated the time series behavior of stock prices in terms of volatility by using variations of GARCH models. An application of GARCH models is available in the article by Berument *et al*(2001), who examine the relation between stock prices and volatility, and report that unexpected stock market returns are

negatively related to the unexpected changes in volatility. One more application of GARCH models is found in the article by Patev *et al*(2004), who report similar results. They argue that an increase in stock market volatility raises the required amount of stock returns, and hence lowers stock prices. Some researchers, on the other hand, report that positive unanticipated returns result in a reduction in conditional volatility; whereas, negative unanticipated returns result in upward movements in conditional volatility. It has also been seen in some cases that there is no evidence of a relationship between mean returns on a portfolio of stocks and the variance or standard deviation of those returns.

But, both these studies report the existence of a significant conditional heteroskedasticity in stock price behavior. No relationship between stock market volatility and expected returns is found. None of these studies; however, has investigated the variation in stock market volatility with respect to day of the week patterns.

In this context, it is important to investigate the source of volatility. It is generally accepted that the volatility depends on two factors: the existing public information and the arrival of new public information. Either kind of information can be accepted as macroeconomic news. French and Roll (1986) report that stock prices are more volatile during trading hours than non-trading hours, and variances of the days after holidays are larger than those of other days. Their explanation is that traders receive public information during trading hours and show a desire to trade while they can.

Two important studies on the public information arrival and time-dependent patterns are found in the article by Samitas(2004). These studies discuss how information is incorporated into pricing and how investors affect prices. The highlight of these studies is the proper description of the way in which liquidity and informed traders affect volume and volatility. The difference between these two studies is the trading assumption of the informed and liquidity traders. Bhattacharya *et al*(2004) examine the stability of the day of the week effect in returns and volatility of the Indian capital market by applying the GARCH Model. Their model brings out the fact that the stock exchange regulations have an effect on the returns.

The study shows that there exists an interesting relation between the mean returns of the day of the week and volatility of mean

returns of other days of the week. However, it cannot be said that this effect is present in the data with which the study has been conducted due to insignificance of the standard deviations over the entire time span and virtually equal coefficient value for all the parameters.

III- Methodology

The day of the week effect can be analysed by means of two methods: ordinary least-square(OLS) technique and GARCH method. In order to apply the OLS technique, we use a dummy variable for each day, except one in which trading took place. But, there are two main problems. One, the error terms in the OLS regression may not form a white noise process at all. This may give us wrong results, and we may draw misleading inferences. The errors in the model may also be correlated. Another, the variance of the error term may not be constant over time. In order to deal with the problem of time varying variance, we allow the variances of the error terms to be time dependent, and capture conditional heteroscedasticity.

Conditional heteroscedasticity can be tackled by means of two broad kinds of models: ARCH and GARCH. Engle (1982) developed the ARCH model, which permits the variances of the forecasted returns to change with the squared lag-values of the previous error terms. This way, the error term of the ARCH model has a zero mean and variance h_t^2, and the model can be written as follows:

$$h_t^2 = \delta_0 + \sum_i^p \delta_i e_{t-i}^2 + v_t \qquad \ldots \qquad (1)$$

where v_t is normally distributed with mean zero and variance σ^2.

However, ARCH models have been developed into GARCH models that overcome the problems of a long lag structure, positive and negative shocks on volatility, and the non-negativity restrictions.

In a GARCH model, the error term has a zero mean and variance h_t^2. The model can be specified as follows:

$$h_t^2 = \delta_0 + \sum_{i=1}^{p} \delta_i e_{t-1}^2 + \sum_{j=1}^{q} \delta_j h_{t-j}^2 + v_t \quad \ldots \quad (2)$$

where v_t is normally distributed with mean zero and variance σ^2.

Equation (2) expresses is a GARCH (p,q) model. The conditional variance may affect the returns from stock markets. The model to capture the "Day of the week" affect can be written in the following form:

$$\log ret_t = \alpha_0 + \alpha_1 mon + + \alpha_2 tue + \alpha_3 thur + \alpha_4 fri + \alpha_1 \log ret_{t-1} + e_t \quad \ldots \quad (3)$$

$$h_t^2 = \delta_0 + \delta_1 e_{t-1}^2 + \delta_2 h_{t-1}^2 \quad \ldots \quad (4)$$

where $logret_t$ is the natural log of the stock market return in period t.

The variables mon, tue, thur, fri denote the day dummies for Monday, Tuesday, Thursday and Friday. We exclude Wednesday to avoid the dummy trap. It is also possible to add some exogenous variables to the GARCH model, and their specifications are usually used in the literature. Kenourgios(2005) includes the volatility of foreign stock returns as an exogenous variable while investigating the conditional variance of the home country stock market. We model the conditional variability by including the day of the week effect into our volatility equation. As a result, the model is written as:

$$H_t^2 = cons + monM_t + tueT_t + thurH_t + friF_t + v_t \quad \ldots \quad (5)$$

IV- Results

The results obtained after estimating the GARCH (1,1) model are stated in Tables- 1.1, 1.2, 1.3, 1.4, 2.1, 2.2, and 2.3, which are given in the Appendix to this article. The return series was calculated using the logarithmic values of the returns on the various days. The returns are defined as the logarithmic difference between the indexes on the two days: the current day and the previous day. The data on the NSE S&P CNX Nifty were collected from the website of National Stock Exchange over the period from the first of January 1998 to the 31st of December 2003.The study has been done in three phases:

1. The first phase looks at daily returns over the entire time span,
2. The second phase looks at the daily returns over the period from the 1st of January 1998 to the 31st of December 2000, and
3. The third phase looks into the daily returns over the period from the 1st of January 2001 to the 31st of December 2003.

For the entire set of observations, the parameter estimates for the returns on individual days are all significant, and it is evident that the returns on Friday are less negative than those on Friday, a finding that works against the general assumption that Friday is a better trading day than Monday. In fact, if we take a closer look at the returns in this case, it is observed that the least returns happen to be on Tuesday.

When we look at Tables -1.1, 1.2, 1.3, and 1.4 for the variances or the risk associated with the returns, it is seen that Friday is the most volatile; whereas, Tuesday has the least variability, and hence a lower figure of the estimated variance. For the first set of observations from the 1st of January 1998 to the 31st of December 2000, the estimated returns on Monday are again higher than those for Friday. All the results obtained are significant, and hence it is yet again seen that, in the case of India, the parameter estimates for the returns on individual days are all significant, and it is obvious that the returns on Monday are less negative than those on Friday, a finding that works against the general assumption that Friday is a better trading day than Monday. In fact, if we take a closer look at the returns in this case, it is observed that the least returns happen to be on Tuesday. When we look at Table-2 for the variances or the risk associated with the returns, it is seen that Friday is the most volatile; whereas, Tuesday has the least variability, and hence a lower figure of the estimated variance. Thus, it is seen that the first half of each day has a significant coefficient, and that the variance is high for the days in which the index takes a low value.

For the other half of the period under consideration, it is seen that none of the coefficient estimates are found to be significant. However, it is seen that, in this case too, the lowest parameter estimate is associated with Friday, which is an indication of low returns for investors on Friday as compared to any other day. The measure of variance is seen to be insignificant. Thus, insofar as the day of the week effect on the volatility is concerned, it is observed that, in the full sample using the GARCH(1,1) model, the volatility as measured by the standard deviations does not have any significant impact on the trading behavior

nor on the returns obtained throughout the period. This reason is good enough to show that, although according to the theoretical information and information on other international stock markets, one might think that similar results would prevail in India to the surprise of all, but it does not.

When we consider the period from January 2001 to December 2003, the measure of volatility is yet again found to be insignificant except for Tuesday and Thursday. Thus, it can be seen that the volatility has an impact on the trading on the middle days, and, in this case, a higher level of volatility is associated with higher returns (although insignificant).

The results definitely go on to prove the absence of the day of the week effect in the National Stock Exchange. The results obtained are quite a true indication in proving the aforesaid. However, one point that must be stressed on is that we do have certain movements or trends operating in the results. If we see the returns associated with Tuesday and Thursday in the latter half of the study period, Tuesday, which has a higher volatility, has comparably lower returns as compared to Thursday, which has a lower significant volatility but higher returns. But, it would be too early to conclude that this is the day of the week effect since, in the entire data set, we get insignificant measures of volatility. Hence, higher or lower levels of volatility cannot be associated with higher or lower returns.

Now, we can say that there exists an interesting relation between the mean returns of the day of the week and volatility of mean returns of other days of the week. However, it cannot be said that this effect is present in the data with which the study has been conducted due to insignificance of the standard deviations over the entire time span and virtually equal coefficient value for all the parameters.

V- Conclusion

The paper has analysed the NSE's S&P CNX Nifty Index. The results show that, over the entire time span, no day of the week plays a critical role in defining the returns or volatility of the stock index. Although every day has a significant coefficient over the entire time span under

consideration, the results indicate that the day of the week factor neither affects the volatility nor the returns in the NSE over the entire time span. However, these conclusions seem to be much ahead of time, and more research in the area may result in better and more convincing results.

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Appendix

Table-1.1: Estimated values of the parameters for the returns on various days for the entire period under study from January 1998 to December 2003.

Variable	Estimated Value	p >|t|
Mon	-0.0030973	0.000
Tue	-0.0042327	0.000
Thu	-0.003088	0.001
Fri	-0.0035511	0.000
Cons	0.0031637	0.000
Rt-1	0.0788679	0.008

Table- 1.2: Results from the application of GARCH(1,1) to the entire model.

Variable	Parameter	p >|t|
Mon	-0.00094	0.023
Tue	-0.00138	0.008
Thu	-0.00082	0.082
Fri	-0.00109	0.025
Cons	0.001261	0.000
R_{t-1}	0.128483	0.000

Table- 1.3: Parameter estimates from the application of GARCH(1,1) to the model containing data for the period from January 1998 to December 2000.

Logret	Coefficient	P>|t|
Mon	-0.00228	0.000
Tue	-0.00246	0.000
Thu	-0.0019	0.001

Fri	-0.00226	0.000
Cons	0.001947	0.000

Table- 1.4: Results obtained for the coefficients for the period from January 2001 to December 2003.

Variable	Parameter	p >|t|
Mon	-0.003833	0.000
Tue	-0.00482	0.001
Thu	-0.0038433	0.000
Fri	-0.00109	0.001
Cons	0.0038472	0.000
R_{t-1}	0.72483	0.000

Table- 2.1: Parameter estimates of the standard deviations for the period from January 1998 to December 2003.

Parameter	Coefficient	p>|t|
Mon	-0.00013	0.214
Tue	1.60E-06	0.984
Thu	-7.1E-05	0.385
Fri	-9E-05	0.355
Cons	0.000708	0.000

Table- 2.2: Parameter estimates of the standard deviations during the period from January 2001 to December 2003.

Parameter	Estimate	P >|t|
Mon	-0.00131	0.241

Tue	-0.00133	0.186
Thu	-0.00116	0.263
Fri	-0.00275	0.005
Cons	0.02156	0.000

Table- 2.3: Estimates of standard deviations over the span from January 1998 to December 2000.

Parameter	Coefficient	p >|t|
Mon	-0.00097	0.117
Tue	-0.00083	0.088
Thu	0.001145	0.014
Fri	0.001029	0.141
Cons	0.004239	0.000