Research Methodology
CHAPTER III
RESEARCH METHODOLOGY

3.1 Introduction

Research methodology is a way of systematically solving the research problem. It deals with the research design used and methods used to present the study. It refers to the systematic method, for defining the problem, collecting the facts or data, analysing the facts and reaching certain conclusions either in the form of solutions towards the concerned problem. It may be understood as a science of studying how research is done scientifically. It explains various steps that are generally adapted by a researcher in studying the research problem.

3.2 Statement of the Problem

A general problem prevailing in most of developing countries is the growth of financial markets. It is not healthy instead debatable. The financial market is playing vital role in the development of economic growth of a country, because it is one of the medium to collect the investments from savers or investors and disseminates the funds to needy via proper channel. However, financial markets in developing countries are volatile in nature.

The stock market volatility is considered to be essential for making investment decisions. Many countries are not able to expand their operation, due to economic slowdown but few countries have managed by implementing effective strategies. In India’s concern, we found that impressive growth in economy, interestingly, the variability and volatility of economic growth was worrying even before the crisis i.e. before liberalization.

Various studies have been conducted by developing countries to test volatility. They have chosen various factors pertaining to volatility and their relationship with volatility like trading volume; trading mechanism, dividend payout and arrival of information etc. Crestmont Research (Report 2011) examined the historical relationship between stock market performance and the volatility in standard and poor’s 500. Their research tells us that higher volatility corresponds to a higher probability of declining market. Lower volatility corresponds to a higher probability of rising market. There is a

It is important to test stock market volatility because it is the one which hinders the performance of the stock market and consumer spending. Most of the research on the stock market volatility in India was based on indices. So apart from market indices, individual stock which has potential to make changes in the market indices also needs to be considered. As the stock market volatility is the unavoidable issue, it is important to revisit the topic stock market volatility in developing countries. The present study is an attempt to accomplish the above mentioned issue and examine some important factors in relation with volatility in quantitative terms.

3.3 Objectives of the Study

1. To study the growth and development of Indian Capital Market.
2. To study the factors influencing stock price volatility.
3. To measure the extent of stock price volatility in selected automobile companies of CNX NIFTY.
4. To forecast the stock price volatility through suitable Non-linear models.
5. To provide suggestions to the stakeholders and policymakers.

3.4 Null - Hypotheses for Testing

In an attempt to study the price volatility in automobile sector shares and forecast the stock price volatility and to fulfill the above objectives the following hypotheses are formulated for testing:

1. NH₁: There is no stationarity in the returns of the companies.
2. NH₂: There is no significant difference among the non linear forecasting models.
3. NH₃: There is no significant difference among various automobile companies share price and volatility of stock market.
3.5 Data and Models Specification Adopted for the Study

The data are based on the financial information provided by the National Stock Exchange of India. Database of the automobile companies listed in National Stock Exchange and indexed under CNX NIFTY during August 2003 to July 2013 (Ten Years) of daily closing price is taken into consideration. In sample selection process, out of the entire listed automobile companies (78 companies), a sample of 48 companies has been selected for research based on availability of data. Finally the selected companies are classified based on their market capitalization, which are further classified under three categories - High, Medium and Low. This classification is based on the following criteria, which is shown in the following table.

Table - 3.14

Market Capitalization wise Companies Distribution

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Criteria for Distribution</th>
<th>No. of Firms</th>
<th>% of Total Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Market Capitalization more than 100 crores</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>Market Capitalization more than 50 crores but less than 100 crores</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td>3</td>
<td>Market Capitalization less than 50 crores</td>
<td>31</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>48</td>
<td>100</td>
</tr>
</tbody>
</table>

3.6 Tools Used for Analysis

1. Return

The daily closing price is converted into returns for which the following formula was used:

\[ R_t = \frac{(P_t - P_{t-1})}{P_{t-1}} \]

Where, \( P_t \) – Current day closing price

\( P_{t-1} \) – Previous day closing price
2. Descriptive Statistics

Under Descriptive Statistics, the Average Monthly Returns (Mean), Standard Deviation, Skewness, Kurtosis and Jarque-Bera Test were used. The details are as follows:

a) Mean

Mean is the average value of the series, obtained by adding up the series and dividing by the number of observations. It is the most common Measure of Central Tendency.

\[ \text{Mean} = \frac{\sum X_i}{n} \]

Where \( i = 1, 2, 3 \ldots n \)

\( n = \) Number of samples

b) Standard Deviation

Standard Deviation is known as the root mean square deviation for the reason that it is the square root of the mean of the squared deviation from the arithmetic mean. It measures the absolute dispersion. Greater the standard deviation, greater will be the magnitude of the deviations of the value from their mean. A small standard deviation means a high degree of uniformity of the observation as well as homogeneity of a series.

The standard deviation of the random variable \( X \) is defined as:

\[ \sigma = \sqrt{E \left( \left( X - E(X) \right)^2 \right)} = \sqrt{E(X^2) - (E(X))^2} \]

\[ = \sqrt{\text{Var}(X)} \]

Where, \( E(X) \) is the expected value of \( X \)

\( \text{Var}(X) \) is the variance of \( X \)

c) Skewness

Skewness is a measure of symmetry, or more precisely, the lack of symmetry. A distribution of a data set is symmetric if it looks the same to the left and right of the center point. Skewness, the third standardized moment, is written as \( \gamma_1 \) defined as
\[ \gamma_1 = \frac{\mu_3}{\sigma^3} \]

Where, \( \mu_3 \) is the third moment about the mean

\( \sigma \) is the Standard Deviation

Skewness can be defined as the ratio of the third cumulate \( k_3 \) and the third power of the square root of the second cumulate \( k_2 \):

\[ \gamma_1 = \frac{k_3}{\sqrt{k_2^3}} \]

The Skewness for a normal distribution is zero, and any symmetric data should have skewness near zero. Negative values for the skewness indicate that data that are skewed left and positive values for the skewness indicate that data that are skewed right. By skewed left, we mean that the right tail is long relative to the right tail. Similarly, skewed right means that the right tail is long relative to the left tail. Some measurements have lower bound and are skewed right. For example, in reliability studies, failure times cannot be negative.

d) Kurtosis

The fourth standard moment is defined as

\[ \gamma_2 = \frac{\mu_4}{\sigma^4} \]

Where, \( \mu_4 \) is the fourth movement about the mean

\( \sigma \) is the Standard deviation

Kurtosis is more commonly defined as the fourth cumulate divided by the square of the variance of the probability distribution.

\[ \gamma_2 = \frac{k_4}{k_2^2} = \frac{\mu_4}{\sigma^4} - 3 \]

e) Jarque-Bera Test

The Jarque-Bera Test is a goodness-of-fit measure of departure from normality, based on the Kurtosis and Skewness. The test statistic JB is defined as
\[ JB = \frac{n}{6} (S^2 + \frac{1}{4}(\kappa - 3)^2) \]

Where, \( n \) = number of observations (or degrees of freedom in general)

\( S \) = the Skewness

\( K \) = the Kurtosis

Under the null hypothesis of a normal distribution, the Jarque-Bera Statistic is distributed with two degrees of freedom. The reported Probability is the probability that the Jarque-Bera statistic exceeds (in absolute value) the observed value under the Null Hypothesis – a small probability value leads to the rejection of the null hypothesis of the normal distribution.

3.7 Econometric Models

3.7.1 Unit Root Test

The study first tests the stationarity of the time series for price changes. Engle and Granger (1982) have shown that many time series variables are non-stationary or different order of integration i.e. I(1) series. Since most of time series have unit roots and are non-stationary as indicated, by Nelson and Plosser (1982) and as proved by Stock and Watson (1988) that conventional regression techniques on non-stationary time series may produce spurious regression. Hence, the Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) tests are employed to infer the stationarity of the series.

a) Augmented Dickey-Fuller Test

Augmented Dickey Fuller (1979) implicitly assumes that the estimated errors are statistically independent and homoscedastic. Heteroskedasticity does not affect a wide range of Unit Root Test statistics. However, a problem will occur if the estimated residual \( \varepsilon \) is not free from autocorrelation since, this invalidates the test. The well-known example of unit root non-stationary is the Random Walk Model. There might be three possibilities for any time series. The time series might be a random walk, a random walk with drift or random walk with drift and time trend. The three possible forms of the ADF test are given by the following equation:
\[ \Delta Y_1 = \gamma_1 y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-1} + \varepsilon_t \]
\[ \Delta Y_t = \alpha_0 + \gamma_1 y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-1} + \varepsilon_t \]
\[ \Delta Y_t = \alpha_0 + \gamma_1 y_{t-1} + \alpha_2 t + \sum_{i=1}^{p} \beta_i \Delta y_{t-1} + \varepsilon_t \]

Where, \( \varepsilon \) is white noise. The additional lagged difference terms are being determined by minimum number of residuals free from autocorrelation. This could be tested for in the standard way such as Akaike Information Criterion (AIC) or Schwartz Bayesian Criterion (SIC), or more usefully by the lag length criteria of the white noise series.

b) Phillip-Perron Test

The distribution theory supporting the Dickey-Fuller tests is based on the assumption that the error terms are statistically independent and have a constant variance. Thus, while using the ADF methodology one has to make sure that the error terms are uncorrelated and that they really have a constant variance. Phillip and Perron (1988) developed a generalization of the ADF test procedure that allows for fairly mild assumptions concerning the distribution of errors. The PP regression equations are as follows:
\[ \Delta Y_{t-1} = \alpha_0 + \gamma y_{t-1} + \varepsilon_t \]

where, the ADF tests correct for higher order serial correlation by adding lagged differenced term on the right-hand side, the PP test makes a correction to the t statistic of the coefficient \( \gamma \) from AR (1) regression to account for the serial correlation in \( \varepsilon_t \). The statistics are all used to test the hypothesis \( \gamma = 0 \), i.e., there exists a unit root. So, the PP statistics are just modifications of the ADF t statistics that take into account the less restrictive nature of the error process.

3.7.2 Nonlinear Models

a) GARCH Model

The (Engle, 1982) Autoregressive Conditional Heteroskedasticity (ARCH) model is most extensively used time series models in the finance literature. The ARCH model
suggested that the variance of residuals at time $t$ depends on the squared error terms from past period. The residual term $\varepsilon$ is conditionally normally distributed and serially uncorrelated. The strength of the ARCH technique is that it uses the established and well specified models for economic variables; the conditional mean and conditional variance are the only two main specifications.

The GARCH model was developed independently by Bollerslev (1986) and Taylor (1986). The GARCH model allows the conditional variance to be dependent upon its own previous lags, so that the conditional variance equation is in the simplest case as now. This is GARCH (1, 1) model which is written as follows:

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta \sigma_{t-1}^2$$

$\sigma_t^2$ is known as the conditional variance since it is a one-period ahead estimate for the variance calculated based on any past information thought relevant. Using the GARCH model it is possible to interpret the current fitted variance, information about volatility during the previous period ($\alpha_1 u_{t-1}^2$) and the fitted variance from the model during the previous period ($\beta \sigma_{t-1}^2$). But in general a GARCH (1,1) model will be sufficient to capture the volatility clustering in the data and rarely in any higher order model estimated or even entertained in the academic finance literature.

b) EGARCH Model

The exponential GARCH model was proposed by Nelson (1991). There are various ways to express the conditional variance equation, but one possible specification is given by:

$$\ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2) + \gamma \frac{u_{t-1}}{\sigma_{t-1}^2} + \alpha \left[ \frac{|u_{t-1}|}{\sigma_{t-1}^2} - \sqrt{\frac{2}{\pi}} \right]$$

The model has several advantages over the pure GARCH specification. First, since the log ($\sigma_t^2$) is modeled, then even if the parameters are negative, $\sigma_t^2$ will be positive. There is thus no need to artificially impose non-negativity constraints on the model parameters. Second, asymmetries are allowed for under the EGARCH formulation, since if the relationship between volatility and returns are negative, $\gamma$ will be
Note that in the original formulation, Nelson assumed a Generalized Error Distribution (GED) structure for the errors. GED is very broad family of distributions that can be used for many types of series. However, owing to its computational ease and intuitive interpretation, almost all applications of EGARCH employ conditionally normal errors as discussed above rather than using GED.

c) TGARCH Model

TGARCH model has been observed that positive and negative shocks of equal magnitude have a different impact on stock market volatility, which may be attributed to a “leverage effect” (Black, 1976). In the same sense, negative shocks are followed by high volatility than positive shocks of the same magnitude (Engle and Ng, 1993). The threshold GARCH model was introduced by Zakoian (1994) and Glosten, Jaganathan and Runkle, (1993). The main target of this model is to capture asymmetry in terms of negative and positive shocks and adds multiplicative dummy variable to check whether there is statistically significant difference when shocks are positive and negative. The conditional variance for the simple TGARCH model is defined by:

\[ R_t = a + bR_{t-1} + \epsilon_t \]

\[ h_t = \omega + \sum_{i=1}^{p} \beta_i u_{t-1}^2 + \sum_{j=1}^{q} \lambda_j h_{t-j} + \delta_t u_{t-1}^2 d_{t-1} \]

Where, \( d_t \) takes the value of 1 if \( \epsilon_t \) is negative and 0 otherwise, identifying “good news” and “bad news” have a different impact.

3.8 Limitations to the Study

1. Since this study is based upon the secondary data, all the limitations inherent to the secondary data will also be applicable to this study.

2. In this research, the special focus is to examine the forecasting volatility for selected stocks in Indian Automobile Sector. The overall patterns, volatility behavior and persistence of information for stock prices are alone considered for the study period.

3. The research opens an area for further study of using other key determining variables like Inflation Rates, Production Index, Gross Domestic Product, Money Supply, Exchange Rate, etc., are the factors not taken into account.
4. This might have resulted in more consolidated results than the univariate analysis employed in this research.

5. Broader and long term issues involving Foreign Institutional Investment, Foreign Direct Investment and Global Meltdown impact in India and their nationwide implications have not been discussed in this research.

6. The analysis is done on CNX Nifty Companies of National Stock Exchange (NSE) alone which only constitutes 99 per cent of the market share which contains fifty major companies of India.

7. The analysis is done on factor influencing the stock market volatility is limited on to particular macro economic factors.

8. The thesis work is limited to the period from August 2003 to July 2013 and is based on daily closing price. In spite of these limitations, it is hoped that the findings will be applicable to identify the status for developing stock markets.

3.9 Scope for Further Research

- This study was conducted for CNX Nifty companies, and the study may be extended to other indices like, S&P SENSEX, Nifty Junior, Nifty Midcaps, Blue Chip Companies, BSE-A Group Companies etc.

- The study can progress further with other macroeconomic factors and also by testing for the lead-lag effect and autoregressive equations.

- This study focused on Stock Price Volatility in India. In future, the study can be undertaken by taking more countries.

- This study is applied only to GARCH, EGARCH and TGARCH models. For further research, the other GARCH family models can be applied.

- The further researchers can use more advanced techniques for modelling volatility such as VaR.