2. Research design

The BSE Sensex was initiated its operations during 1986. It has become gradually the primary proxy for the Bombay Stock Exchange and considered as barometer of Indian economy. The BSE Sensex includes a basket of 30 major stocks which are popularly known as blue-chip companies. The scripts of these companies are traded in weekly five days leaving public holidays. Over the period of time, some companies listed already may be dropped from the list and vice versa on the basis of listing requirements laid down in rules of the BSE. The free float methodology has been used to calculate index level at any point of time frame. Moreover, it influences the market movement of these 30 largest actively traded stocks relative to base period. Every day, stock movements are changed because of existence of volatility in market conditions. The BSE Sensex prices go upward direction, when the stock of major companies on BSE prices goes up and vice versa.

There has been an attempt in this chapter to present research design, review of literature and methodology of the study. The chapter focuses on the objectives of the present study, data collection, period of study, source of study, statistical tools used for the present empirical analysis, scope of the study, limitations of the study and detailed outline of chapters.

2.1. Objectives of the Study

The following are the objectives of present study

(i) To find out the determinants of profitability of select securities for Fixed Effects Panel Data by employing regression analysis;
(ii) To estimate the risk-return of select stocks through the ARIMA model;
(iii) To find out the relationship between risk-return with the help of CAPM model; and
(iv) To analyze the trend in volatility of BSE select stock prices during the period of study.
2.2. Data Collection

From the internal and external sources the secondary data could be taken to the research. This data is already available and collected by the third parties. It is available in the form of sales reports, company annual reports, publications, financial times, websites and journals etc. It is less expensive; secondary information should again be reframed for the purpose of study or research. Moreover, the listed securities under the S&P BSE Sensex are assessed each one separately in either the way i.e. prediction of the returns and the risk. Hence, prediction and validation are ineffective on data abnormalities.

2.3. During the period

The analysis period of the present study is from the financial year 2007-2008 to 2016-2017. For the validation purpose the period is divided into two parts, in which first one is from April 2007 to March 2015 for historical data analysis. And another one is from April 2015 to March 2017 to forecast the data. For the purpose of predicting the future returns and risks the period of two years i.e., ‘April 2017 to March 2019’ has been considered.

2.4. Source of the data

Data were collected from www.bseindia.com. Fortunately this source is authentic secondary source of information relating to stock prices and indices regarding information or data.

2.5. Selection of the sample units and Justification

The sample size of the study is S&P BSE Sensex and its listed 30 companies. The present study considers ‘daily and monthly’ open, close prices of stock as a secondary data. Based on this one can analyze the market trends.

The BSE Ltd is oldest stock exchange in Asia that established in 1875 and had played an interesting role to supply the required funds to the industrial growth of the country for the last 143 years. Sensex is the bench mark index of the BSE Ltd which is considered to be a barometer of Indian Economy. Among many sectorial indices of the BSE Ltd, BSE Sensex comprises 30 of the largest companies in terms of capitalization, turnover and liquidity. Though the importance of the BSE Sensex has dimed with the advent of NSE in 1992 still BSE Sensex is considered as one of the leading stock index in India. With the backdrop of the given background, it is
understood that these sample size of 30 companies drawn from BSE Sensex could be helpful to reach out the predefined objectives of the study.

2.6. Statistical Tools and Techniques

This section concentrates on methods, which are used to analyze the BSE indices daily and monthly time series data. Descriptive statistics, Fixed effects Panel Regression, Beta estimation, Auto Regressive Integrated Moving Average (ARIMA) and GARCH(1,1) approach have been used to find the BSE market situations like volatility and forecasting the profitability and risk. Afterwards, the validity approaches were used to test the normality, stationarity and autocorrelation.

2.6.1. GARCH(1,1) Approach

Several statistical tools such as descriptive statistics, ADF, ARCH-LM and GARCH were applied and analyzed using E-views econometrics package (Wang, 2010). Volatility has been estimated in terms on return (r_i). Therefore, first of all, the daily returns were calculated. The BSE stock index returns are calculated with the help of the following formula. Daily returns are calculated by using the following formula:

\[ R_{it} = \left( \frac{P_{close} - P_{open}}{P_{open}} \right) \times 100 \]  

\[(2.1)\]

\( R_{it} \) is return of the index.

\( P_{close} \) is closing price of the index.

\( P_{open} \) is opening price of index.

2.6.1.1. Descriptive statistics

In order to capture the distributional properties of the daily returns of BSE Sensex during the period under study, the descriptive statistics such as mean, standard deviation, skewness, kurtosis and Jarque-Bera Statistics were used.

2.6.1.2. Unit Root Test

In the use of time series, the Unit root test is appropriate to test whether the data is stationary or non-stationary in character. This can be found out by unit root test with the help of Augmented Dickey-Fuller Test (ADF). ADF formula is as follows:

\[ \Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t \]  

\[(2.2)\]

Where \( \alpha = \) constant

\( \beta = \) coefficient on a time trend
p = lag order of autoregressive process.
γ = 0, which means null hypothesis.
γ < 0, is alternate hypothesis.
y_{t-1} = lagged level of series.

If the test statistic value is less than the critical value then γ = 0 is rejected and no unit root is present. Whereas the null hypothesis is accepted, when the series are integrated then y_{t-1} is not provide relevant information to predict the lagged changes (Δy_{t-k}).

2.6.1.3. Volatility Measurement Technique

As it is noted in the above paragraphs, GARCH model represents the primary methodology to model stock market volatility. Hence, the present study employs GARCH (1,1) to capture volatility in the prices of stock listed on BSE Sensex. To describe the volatility of stock market, the efficient way of financial time series tool is ARCH model. ARCH treats condition variance instead of assuming a constant variance in traditional econometric models. In the real time practice ARCH requires a larger order, which can produce a number of problems like multicollinearity etc. (D. Asterious, S. Hall, (2011)). To solve the existing problems in ARCH methodology, Bollerslev (1992) added auto regressive term, which is named as GARCH model. GARCH(1,1) is the simplest method of GARCH.

\[ Y_t = a_0 + a_1 Y_{t-1} + \varepsilon_t \]  \tag{2.3}

The mean equation had been given in equation (2.3), which represents the function of exogenous variables with an error term.

GARCH variance equation is as follows

\[ \sigma_t^2 = \lambda_0 + \lambda_1 U^2_{t-1} + \lambda_2 \sigma^2_{t-1} \]  \tag{2.4}

\[ \sigma_t^2 = \text{Conditional variance at time } t \]
\[ \sigma^2_{t-1} = \text{Lagged Squared error term in the previous time period } t-1. \]
\[ \lambda_1 U^2_{t-1} = \text{Lagged variance term at time } t-1. \]

Equation (2.4) gives a purpose of a constant \( \lambda_0 \), volatility of the last period \( U^2_{t-1} \) which is specified as part of ARCH, prediction variance from the last period \( U \sigma^2_{t-1} \), which specified by GARCH part, based on the previous periods, the prediction variance is \( \sigma_t^2 \). The GARCH part order 1 represents the first ‘1’ in the
brackets and the second ‘1’ represents the ARCH part with order one in GARCH (1,1). GARCH (p,q) denoted by the higher order of GARCH model, and this can be expressed by the following formula.

\[ \sigma_t^2 = \lambda_0 + \sum_{i=1}^{p} \lambda_i U_{t-i}^2 + \sum_{j=1}^{q} \lambda_j U \sigma_{t-j}^2 \]  

(2.5)

Where \( p \) is order of GARCH and \( q \) is order of ARCH. \( \sum_{i=1}^{p} \lambda_i U_{t-i}^2 + \sum_{j=1}^{q} \lambda_j U \sigma_{t-j}^2 \) is representing the attenuation coefficient, which reflects the persistence of volatility. If \( \sum_{i=1}^{p} \lambda_i U_{t-i}^2 + \sum_{j=1}^{q} \lambda_j U \sigma_{t-j}^2 \) \(<1 \) then GARH process is stationary.

\[ R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it} \]  

(2.6)

Or

\[ r_i - r_f = \alpha_i + \beta_i (r_m - r_f) + \epsilon_i \]

Equation (2.6) represents the regression equation of CAP-M.

\( R_{it} \) = Expected Return on Stock at time \( t \)

\( \alpha_i \) = intercept (risk free rate)

\( \beta_i \) = slope coefficient (beta of individual stock)

\( R_{mt} \) = Market premium at time \( t \) (the difference between the expected market rate of return and the risk free rate of return).

\( \epsilon_{it} \) = Error Term.

\[ \text{2.6.3. BETA Calculation} \]

Beta is a measure to determine the stock market volatility in terms of portfolio or security fluctuations used in fundamental analysis. When evaluating risk, the stock price variability is an important consideration. If the risk could be a possible way of reducing the stock value, certainly beta suits as a proxy for the risk. The systematic risk of a portfolio is measured by Beta. Beta is an important element for capital asset
pricing model (CAPM), which calculates the expected return and cost of equity and it is also called beta coefficient. Mathematical formula for Beta is

\[ \text{Beta} = \frac{\text{Covariance}(r_p, r_m)}{\text{Variance}(r_m)} \]  

(2.7)

\( r_i \) = return of an asset or security (a company registered with Sensex Index)

\( r_m \) = return of benchmark or market (Sensex Index)

If the beta value of S&P BSE Sensex index is 1.0, and individual companies (registered under S&P BSE Sensex) ranks are found according to this value. An individual stock that slaps more than the S&P BSE Sensex over the given period of time has a beta that could be greater than 1.0. If individual security moves less than the index, that means the beta is less than 1.0. Higher the beta higher the risk as well as higher returns, low risk implies the low risk and low returns.

In portfolio management, the scrip selection is usually based on beta of stocks. Portfolio could be followed in many created ways those are differentiated in several sectors, sector wise, and beta wise portfolio.

2.6.4. ARIMA Approach

The ARIMA method was established in 1990s for the prediction of time series (Box and Jenkins, 1976). The main notion of ARIMA model is over the given period of time it forms a predicted object as random series, to take the series of data. To describe the series, a particular statistical technique could be established according to autocorrelation analysis of the time series. Once the technique is constructed, the future values could be predicted through the past and present values of time series.

Moreover, in the prediction process of ARIMA model, it considers dependency of the investigated process and the noise of volatility (Shi and Xie, 2011).

An ARIMA \((p, d, q)\) model is defined as an \(I(d)\) process which \(d\)th integer difference follows a stationary ARMA \((p, q)\) process. In polynomial form:

\[ Y_t = \sum_{i=1}^{p} \varphi_i Y_{t-i} + \varepsilon_t + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} \]  

(2.8)

Where

\( Y_t \) = differenced time series value

\( \varphi \) and \( \theta \) = unknown parameters

\( \varepsilon \) = independent identically distributed error terms with zero mean.

\( Y_t \) could be expressed as past and current values as well as past error terms.
In ARIMA model, stationarity, invertibility and parsimony are the three important parameters that are used in identification, estimation and diagnostic checking respectively (Asteriou, D. and S.G. Hall 2015).

The mean, variance and covariance are constant over the given time in stationarity process. This could be accomplished by differencing either the integrated order one (I(1)) or two(I(2)). In the process of invertibility, $Y_t$ measured by convergent autoregressive process (moving average of finite order). Box and Jenkins assumed that parsimony is a model, which produces well forecasting with extra coefficients and degree of freedom would be affected. This model is better than an over parameterized model. In this study the ARIMA forecast for the period of March 2017 to April 2019 was modeled by organizing the EViews software which is applied for econometric analysis of time series.

2.6.4.1. Identification Phase

In this stage, the Augmented Dickie Fuller (ADF) test is used to ensure the level of data series is stationary.

$$Y_t = \rho y_{t-1} + x_t^\delta + \epsilon_t \quad (2.9)$$

Where

$x_t$ consider as constant and trend $\rho$ and $\delta$ are estimated parameters, which assumed to be white noise. If $|\rho| \geq 1$, $y$ is non-stationary series and the variance of $y$ increases with time and approaches infinity. If $|\rho| < 1$, $y$ is trend / stationary series. Hence, the hypothesis of trend / stationary series can be evaluated by testing whether the absolute value of $\rho$ is strictly less than one.

2.6.4.2. Estimation through Auto ARIMA Approach

In this estimation stage, different ARIMA models are estimated using Akaike Information Criteria (AIC). AIC is used to determine the model best fits a set of data series and it chooses the best model to forecast the future data. This is based upon the estimated log-likelihood of the model, number of observations and number of parameters in the model. By using ARIMA models, the number of Auto Regressive Moving Average (ARMA) terms could be determined. The maximum number of Auto Regressive (AR) or Moving Average (MA) coefficients has been specified to determine the number of ARMA terms, then to estimate every model up to those maxima and then each model could be evaluated using its information criterion. After
estimating each model along with calculated criterion, the model could be chosen based on lowest AIC.

2.6.4.3. Diagnostic Check

Auto correlation (AC) and Partial Auto Correlation (PAC) are the two types of correlation coefficients for correlogram. The Auto Correlation function (ACF) represents the correlation of current first differencing returns with its 12 lags. The ACF is calculated by the following formula

\[ \hat{\rho}_k = \frac{r_k}{\gamma_0} \]  

(2.10)

\( \hat{\rho}_k \) is ACF from the given sample

\( r_k \) is covariance at lag \( k \)

\( \gamma_0 \) is the sample variance.

The Partial autocorrelation function (PACF) indicates the correlation between ‘n’ observations and intermediate lags. ACF and PACF are used by the Box Jenkins methodology to identify the type of ARMA model to determine the appropriate values of \( p \) and \( q \).

2.6.5. Fixed Effects Panel Model

Fixed effects panel model explains that the individual effects are either random or not random but correlated with explanatory variables, and it represents a subject specific means. This could be expressed in the following formula.

\[ Y_{it} = m \left( X_{it}, \frac{t}{T} \right) + \alpha_i + e_{it} \]  

(2.11)

Where

\( Y_{it} \) = dependent variable

\( X_{it} \) = independent or explanatory variable

Covariates \( X_{it} = (X_{it}, 1 \ldots X_{it,p})^T \), dimension \( p \)

\( \alpha_i \) = unobserved individual effect, which is equal to zero and may be correlated with \( X_{it} \)

\( i = 1 \ldots N \)

\( t = 1 \ldots T \)

\( e_{it} \) = random errors, which are independent and identically distributed

Profitability: Measured by net profit margin (NPM)

\( \text{SIZE}_{i,t} \) : Size of the firm

\( \text{ROA}_{i,t} \) : Return on Assets
ATR_{i,t} : Asset Turnover Ratio  
LIQ_{i,t} : Liquidity Ratio (Current Ratio)  
ITR_{i,t} : Inventory Turnover Ratio  
RER_{i,t} : Retained Earnings Ratio  
DER_{i,t} : Debt equity Ratio  

A fixed effects panel data model refers to a regression model, which specifies that the fixed group means. Each group mean is a group specific fixed quantity.

2.7. Hypotheses of the study

The following hypotheses are tested.

Null Hypothesis: The profitability is explained by its determinants. In this juncture whether the considered determinants or factors are affecting the profitability or not has been checked.

H01: There is no statistical significant effect on profitability of securities and considered factors under the study.

Alternate Hypothesis: The considered determinants or factors are explaining the profitability of individual security.

H11: There is a statistical significant effect on profitability of securities and considered factors under the study.

Null Hypothesis: The systematic risk always affect the expected returns; therefore the study examines whether the relation is existed between systematic risk and expected returns or not.

H02: There is no significant relationship between systematic risk and the expected return for assets or stocks.

Alternate Hypothesis: The expected return depends on the systematic risk.

H12: There is significant relationship between systematic risk and the expected return for assets or stocks.
**Null Hypothesis:** Beta is most appropriate measurement to find the systematic risk; in this perspective whether the fluctuation of systematic risk of individual security is relating to the movements of the S&P BSE Sensex index.

_H03:_ There is no significant relationship between each security’s systematic risk and BSE Sensex Index movements.

**Alternate Hypothesis:** The relation between beta and BSE Sensex index movements are even.

_H13:_ There is significant relationship between each security’s systematic risk and BSE Sensex Index movements.

**Null Hypothesis:** The individual security returns are unequally correlated with the index returns.

_H04:_ There is no significant relationship between each security’s return and BSE Sensex Index movements.

**Alternate Hypothesis:** The individual security returns and index returns have the equal movements.

_H14:_ There is a significant relationship between each security’s return and BSE Sensex Index movements.

**Null Hypothesis:** Volatility is measured by using the stock market returns, in this context whether the stock returns relate to the fluctuations or not.

_H05:_ There is no significant relationship between daily stock returns and volatility.

**Alternate Hypothesis:** prediction of the relationship between stock market returns and volatility of those particular stocks are exited.

_H15:_ There is a significant relationship between daily stock returns and volatility.
2.8. Scope of the Study

- Whether the study focuses on the dynamics in stock price moments?
- Focus on risk and return predictability:
  - On which type of risk the investor is ready to take up?
  - What is the target return for the investor in specified risk?

2.9. Limitations of the study

No study is exceptional to the completeness.

- The present study covers only BSE Sensex leaving all the sectorial indices incorporated within otherwise these would have included under the coverage of the study.
- Further, along the BSE, there are other national stock exchanges which are also considered as imperative stock exchanges in Indian economy.
- But due to lack of time, difficulty to arrive uniformity in some variables, which has been ignored for the study.

2.10. Organization of the thesis

Chapter one specifically gives a detailed introduction of stock and stock market especially Bombay Stock Exchange, Capital Asset pricing Model, risk element, profitability analysis and relationship of risk and return. Chapter two highlights research design and methodology relating to significance of the BSE Sensex, statement of the problem, review of literature both theoretical and empirical, the problem identified from the literature. Furthermore, this chapter describes, objectives, collected information, statistical tools, scope of the study, limitations of the study and chapter outline.

Chapter three discusses the empirical time series analysis of profitability determinants, forecasting and validating the return series through auto ARIMA approach. Furthermore, risk forecasting and validating by applying auto ARIMA approach. Chapter four analyses the forecasted results of risk and return incorporated into the Capital Asset Pricing model and found the relationship between risk and return. In addition to this volatility measurement has been done and validated with the help of GARCH (1,1) model. Chapter five presents the findings, suggestions and conclusion.