Chapter 2

Economic Analysis & Research Methodology:
An Introduction

2.0. Introduction

The stock market is considered to be a concurrent part of economies since it allows redistribution of financial resources among separate economic entities. Having used stocks, governments and companies may be provided with necessary financial means and household establishments while other economic entities are able to invest their savings into such ranges of economy which are supposed to be reliable and are expected to be profitable. The reciprocal relation between the development of stock market and changes in the country's economy was noticed long ago: as soon as the economic situation in the country improves the stock market performs more actively. The stock market performance is supposed to illustrate the state of the country's economy: if stock prices start to fall, economic depression is likely to take place and, conversely, rising stock prices show possible economic growth. Stock market indices are the statistical indicators which enable us to show the state of the stock market and its dynamic tendencies. Considering the state of the world financial system which is getting more and more complicated, it is important to find out what factors influence fluctuations of stock market indices in separate countries. The impact of macroeconomic indicators on stock markets as well as on their indices has been emphasized in scientific literature recently and has become more relevant for
the two recent decades. The relation between macroeconomic indicators and stock prices is confirmed in the most academic works, although there is a lack of comprehensive assessment of causality and dependence of macroeconomic indicators and stock market in regard to the time and changing macroeconomic processes. That is why the model of the impact of macroeconomic indicators on the stock market index, which enables to reveal a complex assessment of causality and dependence of the relation between macroeconomic indicators and stock prices during the long and the short runs becomes a logical prolongation of an existent academic analysis. Therefore, the problem to be tackled in this chapter is how to present a complex estimation of the impact of macroeconomic indicators on the country’s stock market index. The objective of the proposed research plan is to study the impact of macroeconomic indicators on stock market index. The objective of the scientific work is to create the model of the impact of macroeconomic indicators on stock market index, which could enable us to present a complex estimation of causality and dependence of the relation between macroeconomic indicators and stock market index during the long and the short runs. Applied research methods are the logical tools to be used in the analysis.

The model of the impact of macroeconomic indicators on stock market index, which enables to present a complex estimation of causality and dependence of the relation between macroeconomic indicators and stock market index during the short and the long runs, has been created. Compared with other scientific works this model is consistent and includes methodologically reasonable principles in estimation of the relation between macroeconomic indicators and stock market index.
2.1. Review of Literature

The performed analysis of practical use of the model of the impact of macroeconomic indicators on stock market index in India, supplemented the topics of the scientific researches analyzing the relation between macroeconomic indicators and stock market index, also enabled to interpret these relations from a viewpoint of an investor. The researches show that stock market is treated as a part of securities market where the stock trade is organized and performed. The main purpose of stock market indices is to ensure for investors possibility to estimate not only the state of separate stocks but the state of the entire market, sector or region. On the other hand, macroeconomic indicators are treated as statistical indicators which are used for assessment of general state of the country’s economy during a certain period of time (Rogers, 1998) or as regularly published governmental statistics which reflects the economic situation in the specified country (Mohr, 1998). Macroeconomic indicators may be classified by their connection with the country’s business cycle. The performed analysis of the concepts of macroeconomic indicators and stock prices in the context of assessment of macroeconomic processes enables to find certain prerequisites of their relation, which are confirmed by the performed researches. Having summarized the performed analysis the following prerequisites of the relation between macroeconomic indicators and stock prices are formulated:

Valid methods of research, which would enable us to assess the relation between the country’s macroeconomic indicators and stocks prices comprehensively.

It was found that an objective determination of this relationship should
be grounded not only on relevant selection of macroeconomic indicators but also based on the methodology of the researches giving a complex assessment of the variations in the relationship between macroeconomic indicators and stock market index during the long and the short runs. Academic economic models present the methods which are mostly oriented to quite narrow interpretations of this relationship. Whereas, in economic literature, there is a lack such methods which could unite the criteria of selection of macroeconomic indicators and the methods of estimation of causality and dependence of the relationship between macroeconomic indicators a stock market index and enable to increase reliability of the relationship between macroeconomic indicators and stock market index. That shows that scientific literature does not present a completed and general conception of the impact of macroeconomic indicators on stock market index which could enable to assess macroeconomic processes thoroughly and forecast their variations’ relationships.

As already discussed, the Fundamental analysis provides an overall view of the economy, industry and company related factors which help in investment decisions. In a top-down approach, the first such analysis is economic analysis. This analysis scrutinizes both the macro and micro economic performance represented by stock market index. Economic analysis establishes the relationship between movement of economic factors and stock market performance. The trends of stock prices relative to economic factors can be used by an investor to select the right investments. More so, the economic analysis aims at determining if the economic climate is conducive and is capable of encouraging the growth of business sector, specially the capital market. It can be seen that
when an economy expands, most of industry groups and companies are also expected to be in benefit. Similarly, if an economy declines, even the survival of most of the industries and companies become difficult. In view of this, if a share price is to be predicted, an investor will have to explore the operating forces (economic factors) in the overall economy.

More so, in an international investment setting, one has to explore global economy in respect of involved factors. The selection of a country for investment has to focus itself on examination of national economic scenario. In view of above, it is important to forecast the direction of national economy because its activities affect corporate profits. A zero growth rate or slow growth rate of the economy can lead to reduced business profits and consequently lower share prices.

Fundamental analysis implies the examination of factors/tools for economic analysis.

King B. F. (1966) states that, on an average, more than half the variation in the share prices can be attributed to market influence which, in turn, affects all stock market indexes. However, share are also subject to industry influence, this industry influence explains, on an average, about 13% of the variation in share prices. On the whole, as per his research, about two-third of the variation in share prices can be attributed to economy and industry. A few related problems are

are far more volatile then can be justified on the basis of real economic variations. Such conflicting results have been put forth by many research studies like: Horna K., and Jaffe D. (1971), Hamberger J. M. (1974) and Kochin I. (1972), Melkiel B. and Quand R., (1972), Rundolph J. (1972), Reilly F. K., Johnson G. L. and Smith R. E. (1970)

2.2. Forecasting Models in Economic Analysis

A close scrutiny of the fundamental factors can help an investor in investment decisions in the secondary market. A large number of economic forecasting models or tools have been developed which helps in forecasting the trend of the share market. In this regard, the application of the relevant statistical techniques and econometric models have been developed for forecasting purposes. Here it is assumed that the behavior of the past data is indicators of future performance. An econometric model is usually expressed as a mathematical relationship based on past behavior of a set of variables within some bounds of statistical probability, that is, within a specified degree of confidence. In the simplest form of the model, a single variable is analyzed based solely upon trends in its own past behavior without providing any consideration to trends in other variables.

Still more complex econometric models have been developed which incorporate the use of explanatory factors or variables in model construction and analysis. Such models are termed as “Stochastic” and assume that the behavior of variables whose trend is to be analyzed is based upon other external influences and as such are not predictable.
In practice, exponential smoothing, univariate autoregressive moving average, simple correlation and regression, multiple regression and partial correlations are models used in analyzing the macroeconomic variables. These models are used to explain relationship between specific independent variables (or a set of such variables) and a single dependent variable. The other models, also called time series models, are used for forecasting a target variable and using past trends in the data itself to make predictions about its future behavior.

To determine the proper price of a firm's stock, the security analyst must forecast the dividend and the earnings that can be expected from the firm. This as discussed is the heart of the fundamental analysis: that is, the analysis of the determinants of value of such earnings prospects. Ultimately, the business success of the firm determines the dividend it can pay to shareholders and the price it will command in the market, because the prospects of the firm are tied to those of the broader economy, however, fundamental analysis must consider the business environment in which the firm operates. For some firms, macroeconomic and business environment might have a greater influence than the firm's relative performance within its industry. In other words, the investor needs to keep the big economic picture in mind.

Therefore, in analyzing the firm's prospect it often makes sense to start with the broad economic environment, examining the state of aggregate economy and even international economy. From there, one considers the implications of the outside environment on the industry in which the firm operates. We begin with a discussion of international factors relevant to firm's performance, and move
on to an overview of the significance of the key variables usually used to summarize the state of the macro economy. We then discuss the government's macroeconomic policy. We finally conclude with a discussion of business cycle.

A top-down approach of a firm's prospects must start with the global economy. The importance of the global economy has evolved significantly in the last two decades due to deregulation of the financial markets and the product and technological developments. The world has entered an era of unprecedented internationalization and globalization of economic activity. The international economic factors today even impact those concerns who do not have foreign exchange exposure and are purely domestic in their operation. With the globalization, the world has integrated financially that one economic event affecting one part of the globe has an impact on the profitability and survival of the businesses on the other part of the world.

A close scrutiny of fundamental factors has led to investment suggestions in the secondary market. Many analysts have developed economic forecasting models/tools that help in forecasting the trend of the share market.

The application of statistical analysis and econometrics to forecasting is based on the premises that past data are indicators of future performance. An econometric model is usually expressed as mathematical relationship or a set of equations, based upon the past behavior of a set of variables within some defined bounds of statistical probability, that is specified level of confidence. These models are formulated and used to predict the future behavior of share prices. In its simplest form, a single variable is analyzed based solely upon trends in
its own past behaviour with no consideration given to external factors, influences or other variables which may have significant effect upon its behaviour. Such models are termed as “deterministic” and are based on the assumption that the past trend of the variable whose behavior is being attempted to be explained contains all the information necessary to predict its future behavior.

More complex econometric models incorporate the use of external or explanatory factors or variables in model construction and analysis. Such models are termed “stochastic” and assume that the behavior of the variable that is being attempted to be explained is based upon other, external influences and therefore is by itself not predictable. This necessitates establishment of the correlation between and among variables. Such models additionally help to perform impact analysis and develop a variety of ‘what if’ scenarios to assess various output effects based on changes in inputs or explanatory factors.

A third type of econometric model is a hybrid of the deterministic and stochastic model structures. These models, termed structural time series models are essentially, deterministic (time series) in that they involve complex mathematical processes (algorithms) in attempting to explain the variable’s behavior from its prior trends, for example seasonality trends or repetitive cycles. However, they are also stochastic (structural) in that they incorporate the effects of external influences and explanatory factors, a fundamental shortcoming of the deterministic model.

In general, these models encompass structural time series modeling techniques using both the inherent predictable nature of the data along with
external factors that may, to some extent, influence the behavior of the variables used in forecasting. In practice, different types of models for example exponential smoothing, univariate autoregressive moving average, multivariate autoregression, ordinary least squares, simultaneously equation, and so on are choosen based upon the qualitative and quantitave characteristics of the data to be used.

The development of statistically based econometric model result in two basic types of structures:

(a) Structural or cross sectional models, which are used to explain casual relationship between a specific independent variable or set of such variable and a single dependent variable

(b) Time series models, which are oriented more towards forecasting a target variable and using past trend in the data itself to make predictions about its future behavior.

2.2. (a) Structural or Cross Sectional Econometric Models

By their very nature, a structural econometric model are very complex and generally requires that precise rules be followed with respect to the selection of explanatory variables, the requirement of minimal influence among the selected explanatory variables, and in the direction of the flow of causation. A fundamental assumption of this type of modeling process is that the independent variable or variable cause changes to occur in the dependent variable and not vice versa.

One of the most important features of this type of structural analysis is the models ability to describe the separate and unique influences that each independent variable will have on the dependent variable. However, if the
explanation of an independent variables contribution to the dependent variable behavior is not significant statistically, then related independent variables may be used together as a factor and thereby improving, the model's predictive capabilities. In this instance, all correlated variables are grouped together as a factor that has as a predictive power better than the individual variables separately.

A fundamental objective in such econometric modeling process is to include all important explanatory variables while simultaneously not crossing the threshold of using too many variables (a condition called over-parameterization) and particularly too many correlated independent variables. The inclusion of correlated independent variables is called multicollinearity. Multicollinearity and over parameterization reduces and relevance of the econometric model and does not lead to a good solution.

Through the use of more than one explanatory variable (multivariate or multiple regression analysis) and multiple equation structures (simultaneous equation models) the structural econometric model has the ability to “model” or simulate highly complex and interdependent business and economic relationship.

Structural econometric models are best suitable to the analysis of highly complex economic structures and systems and can provide more precise and detailed estimations of interactions and linkages between and among variables chosen for the model. However, when placed in a forecast role, these models may prove cumbersome and relatively inefficient due to their inherent data requirements and the need to develop individual forecasts for the explanatory variables.
2.2. (b) Time Series Econometric Models

Time series econometric models are designed for only fundamental purpose namely, forecasting. They are generally inappropriate in being able to explain with any degree of precision the nature of relationships between specific explanatory independent variables and the dependent variable. Consequently, time series models are generally not well suited to impact analysis and they do not adjust well to external shocks and influences. Therefore, such models have only limited usefulness in a “what if” or scenario based modeling environment. Nonetheless, time series forecast models are still used due to their simplicity in application to time series data and their ability to analyze complex underlying trends, cycles and season ability in the data series.

Early time series forecast methods, for example the autoregressive integrated moving average (ARIMA) process, using the uni-variate (single-variable) Box-Jenkins technique, were popular because of its simplicity as a forecasting tool. Its use in forecasting necessitated little or no complex model specification, nor any extensive knowledge of economics or consideration of external influences, linkages or correlation with respect to the variable to be analyzed and forecasted. This econometric modeling and forecasting process is however deterministic because the models structure is determined solely by the historical characteristics of the data. The underlying assumption in the ARIMA model is that 'history will repeat itself'. Hence to adequately fit this forecasting model, historical data must show predictable trends and consistent pattern of trend, seasonality and long term business cycle.
Time series econometric models do not incorporate important economic happenings and external influences. Consequently, they have been found to be inadequate in adjusting to sudden shocks in the forecasting environment. Besides the ARIMA, other models have also helped analysts to determine the market forecasts.

2.2. (c) Structural Time Series Models : A Hybrid

Structural time series models are the multivariate autoregressive models. These models are of a multivariate form using sophisticated autoregressive methods as applied to a number of variables simultaneously. The multivariate time series process incorporates economic relationships and interdependencies through variable interactions. In the initial development of the model, all variables are considered endogenous, that is, all models variables are presumed to be determined within the model's structure and used simultaneously to explain one another. Once relationships among and between variables are statistically tested as significant and the final variables selected, then the influences is specified by more formally establishing which variable or variables are to be considered exogenous, that is, determined outside the model structure.

The multivariate time series modeling process has the unique capability of taking distinct groups of time series data and, through an inherent optimization process of the model, determine statistically relevant inter-dependencies and correlations. Forecasts may then be developed either deterministically, that is, internally by the model based on the prior behavior of the independent variables,
or jointly, (deterministically or stochastically) based on external explanatory variable forecasts.

Despite the sophistication and ease of use of such modeling techniques, there exists a controversy over the appropriateness of applying time series modeling. This is mainly due to the fact that the explanatory variables in a multivariate time series modeling cannot be viewed discreetly with respect to their impact on dependent variable. Consequently, the multivariate time series models allows for only a “joint causation” to be inferred.

2.3. The Barometer of Indian Capital Markets

2.3. (a) Sensex : An Introduction

SENSEX, first compiled in 1986, was calculated on a “Market Capitalization-Weighted” methodology of 30 component stocks representing large, well-established and financially sound companies across key sectors. The base year of SENSEX was taken as 1978-79. SENSEX today is widely reported in both domestic and international markets through print as well as electronic media. It is scientifically designed and is based on globally accepted construction and review methodology. Since September 1, 2003, SENSEX is being calculated on a free-float market capitalization methodology. The “free-float market capitalization-weighted” methodology is a widely followed index construction methodology on which majority of global equity indices are based; all major index providers like MSCI, FTSE, STOXX, S&P and Dow Jones use the free-float methodology.

The growth of the equity market in India has been phenomenal in the present decade. Right from early nineties, the stock market witnessed heightened
activity in terms of various bull and bear runs. In the late nineties, the Indian market witnessed a huge frenzy in the "1M1" sectors. More recently, real estate caught the fancy of the investors. SENSEX has captured all these happenings in the most judicious manner. One can identify the booms and busts of the Indian equity market through SENSEX. As the oldest index in the country, it provides the time series data over a fairly long period of time (from 1979 onwards). Small wonder, the SENSEX has become one of the most prominent brands in the country.

SENSEX : Calculation Methodology

SENSEX is calculated using the "Free-float Market Capitalization" methodology, wherein, the level of index at any point of time reflects the free-float market value of 30 component stocks relative to a base period. The market capitalization of a company is determined by multiplying the price of its stock by the number of shares issued by the company. This market capitalization is further multiplied by the free-float factor to determine the free-float market capitalization.

The base period of SENSEX is 1978-79 and the base value is 100 index points. This is often indicated by the notation 1978-79 = 100. The calculation of SENSEX involves dividing the free-float market capitalization of 30 companies in the Index by a number called the Index Divisor. The Divisor is the only link to the original base period value of the SENSEX. It keeps the Index comparable over time and is the adjustment point for all Index adjustments arising out of corporate actions, replacement of scrips etc. During market hours,
prices of the index scrips, at which latest trades are executed, are used by the trading system to calculate SENSEX on a continuous basis.

2.3. (b) Nifty : An Introduction

The S&P CNX Nifty (Nifty 50 or simply Nifty) is a composite of the top 50 stocks listed on the National Stock Exchange (NSE), representing 24 different sectors of the economy. It is a simplified tool that helps investors and ordinary people alike, to understand what is happening in the stock market and by extension, the economy. If the Nifty Index performs well, it is a signal that companies in India are performing well and consequently that the country is doing well.

An upbeat economy is usually reflected in a strong performance of the Nifty Index. A rising index is also indicative that the investors are gung-ho about the future. The Nifty Index is based upon solid economic research. It is internationally respected and recognized as a pioneering effort in providing simpler understanding of stock market complexities.

Nifty is the flagship index of NSE, the 3rd largest stock exchange in the world in terms of number of transactions (Stock Futures).

Company focused upon the index as a core product. IISL has a marketing and licensing agreement with Standard & Poor’s.

The S&P CNX Nifty covers 22 sectors of the Indian economy and offers investment managers exposure to the Indian market in one portfolio. The S&P CNX Nifty stocks represent about 60% of the total market capitalization of the National Stock Exchange (NSE).
The base period for the S&P CNX Nifty index is November 3, 1995, which marked the completion of one year of operations of NSE’s Capital Market Segment. The base value of the index has been set at 1000, and a base capital of Rs 2.06 trillion [1].

2.4. Research Design and Methodology

The statement and objectives of the proposed research plan and a detailed review of the related studies have been the subject matter of the preceding chapters. In the present chapter, an attempt has been made to discuss, in detail, the research design and statistical methodology adopted in meeting the objectives of the proposed research plan.

In any statistical analysis of the data, one has to pass through some definite applied scientific stages. These stages are:

1. Collection of data.
2. Organization of data.
3. Presentation of data.
4. Analysis of data.

Before going for the above stages in the analysis, we first mention the ‘Target Population’ in the research plan.

2.4. (a) Target Population in the Research Plan

Initially, we define the target population in the study. As per the research plan, our study is based upon the analysis of certain representative dependent
and independent variables. In statistics, the population is defined as a well defined set, group or aggregate of observations related to some phenomenon (Variables) under investigations.

Accordingly, as per the objective, the population in the present study is formulated as:

"Analysis of secondary market performance with variations in macroeconomic variables in the two triennium economic blocks"

In view of the objective, the variables in the proposed study can be classified as

The Dependent Variables.

The Independent Variables.

2.4. (b) The Dependent Variables

We define the dependent variable as the variable we wish to predict by, or understand the relation with, the independent variable. The independent variable is also called explanatory or predictor variable. As per the framework of the proposed research plan, we observed that the study relates to Economic Analysis. As such, Sensex and Nifty, representing secondary market performance in the two triennium blocks have been considered as the two dependent variables. In the statistical analysis of the concerned data, these variables have been denoted as:

\[ Y_1 : \text{NIFTY in the first triennium economic block (1994-1997)}. \]

\[ Y_2 : \text{SENSEX in the first triennium economic block (1994-1997)}. \]


2.4. (c) The Independent Variable

There are various ways in which the stock market and the macro economy have been related. For obvious reasons, macroeconomic variables in this two-way relation ship have been put in the category of independent variables. Independent variables in the statistical analysis are generally denoted by $X$. Some of the independent variables representing some of the macroeconomic variables used in the study are:

$X_1$ : Growth rate of the gross domestic product.

$X_2$ : Industrial growth rate.

$X_3$ : Agriculture & monsoon.

$X_4$ : Savings & investments.

$X_5$ : Government budget & deficits.

$X_6$ : Price level & inflation.

$X_7$ : Interest rates.

$X_8$ : Cash reserve ratio.

$X_9$ : Balance of payment.

$X_{10}$ : Foreign capital flow (FDI + FII).
2.5. Sample and Source of Data

After identifying the dependent and independent variables in the study, quarterly secondary sample data on these variables in two triennium economic blocks of the respective durations (1994-1997) and (2003-2006) was collected and summarized in Tables: A₁, A₂, A₃, and A₄.

2.6. Statistical Methodology used in Data Analysis

2.6.1. Simple/Multiple Regression Analysis

Regression analysis is one of the most important and widely used statistical techniques and has many applications in business and economics. This now refers to a statistical technique of modeling the relationship between variables. As an example, a firm may be willing in estimating the relationship between advertising and sales which can be the most important topic of research in the field of marketing. Thus, as a first step, we model the relationship between two variables, a dependent variable denoted by Y, and an independent variable, denoted by X. The model we use is a straight line relationship between X and Y. On the other hand, when we model the linear relationship between the dependent variable Y and a set of several independent variables, we make use of a statistical technique called linear multiple regression.

2.7. Model Building

In regression model building, we make use of some statistical terminology. The same is being added for stand by clarification.
Table: $A_1$

Quarterly Data on study variables in the first triennium economic block

(1994-1997) Nifty $Y_1$, being the dependent variable.

<table>
<thead>
<tr>
<th>Quar.</th>
<th>Years</th>
<th>$X_1$</th>
<th>$X_2$</th>
<th>$X_3$</th>
<th>$X_4$</th>
<th>$X_5$</th>
<th>$X_6$</th>
<th>$X_7$</th>
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<td>100.97</td>
<td>101</td>
<td>57058</td>
<td>5463.33</td>
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<td>15</td>
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<td>7232</td>
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<td>243783</td>
<td>103.6</td>
<td>102</td>
<td>62245</td>
<td>1994.33</td>
<td>111.6</td>
<td>15</td>
<td>14.5</td>
<td>7310</td>
<td>4059</td>
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</tr>
<tr>
<td>Q3</td>
<td>1994-95</td>
<td>264099</td>
<td>110.9</td>
<td>103</td>
<td>67432</td>
<td>2053.66</td>
<td>113.46</td>
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<td>104</td>
<td>72619</td>
<td>9723.33</td>
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Sources: RBI website www.rbi.org.in
**Table: A2**

Quarterly Data on study variables in the first triennium economic block

(1994-1997) Sensex $Y_2$, being the dependent variable.

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Sources: RBI website www.rbi.org.in
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Quarterly Data on study variables in the first triennium economic block.
(2003-2006) Nifty \( Y_3 \), being the dependent variable.

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Sources: RBI website www.rbi.org.in
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Quarterly Data on study variables in the first triennium economic block
(2003-2006) Sensex Y₄, being the dependent variable.

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Sources: RBI website www.rbi.org.in
2.7. (a) **Statistical Terminology**

We have used a number of statistical terms in the thesis. A list of these terms is provided for clarifications.

**Macroeconomics**: Macroeconomics is concerned with the analysis of the behavior of the economic system in totality. Thus, macroeconomic studies how the large aggregates such as total employment, national product or national income of an economy and the general price levels are determined. Macroeconomics is therefore a study of aggregates. Besides, macroeconomics explains how the productive capacity and national income of the country increase over time in the long run.

**Linear or Straight Line Relationship**: In case we model the relationship between two variables, a dependent variable denoted by \( Y \), and an independent variable, denoted by \( X \). The model we use is a straight line relationship between \( X \) and \( Y \).

**Linear Multiple Regression**: When we model the linear relationship between the dependent variable \( Y \) and a set of several independent variables. Then the concerned model is termed as multiple linear regression model.

**Population**: In statistics, the population is defined as a well defined set group or aggregate of observations related to some phenomenon (variables) under statistical investigation.

**Sample**: A part or small section of the population is called a sample which is often used to provide an estimate of some characteristic of the entire population.
**Dependent Variable**: We define the dependent variable as the variable we wish to predict by the independent variable.

**Independent Variable**: There are many ways in which variables have a two-way relationship. The independent variable is also called explanatory or predictor variable.

**Correlation**: Correlation coefficient is the quantitative measure of the strength of linear relationship between two variables.

**Correlation Analysis**: Correlation analysis seeks to determine the degree of relationship between two variables.

**Coefficient of Determination**: Coefficient of determination is a measure which indicates how well the linear regression model is fitted to the bivariadic data. This indicates the percentage of the total variation in the dependent variable as explained by independent variable.

**Standard Error of Estimate**: Standard error of an estimate is a measure of the scatter of the observation about an average line, also called the regression line.

**Regression Line**: Method of least square is used to determine the line of the best fit to observed bivariadic data set. These lines of best fit are also called regression lines.

**Multiple Correlation**: The linear multiple regression help us to study the joint effect of a group of variables upon a variable which is not included in the group. It is a statistical technique which defines the equation of best fit.
in least square sense, between a dependent variable and two or more independent variables.

**Standard Error of Estimate**: Like two variable case, in multivariable case also, we need a quantitative measure useful to indicate how precise the prediction of dependent variable is, based on two or more independent variables. The standard error of estimate provides us such a measure.

**Coefficient of Multiple Determination**: The coefficient of multiple determination is an extended concept similar to that of coefficient of determination in two variable case. This also explains the percentage of variation in the dependent variable which is explained by the independent variables.

**Partial Correlation**: The partial correlation coefficient measures the correlation between a dependent variable and one particular independent variable when all the remaining variables involved are kept constant, i.e., when the effect of all other variables are removed.

**Analysis of Variance (ANOVA)**: A method of making statistical comparisons of more than two population means is called ANOVA.

2.7. (b) **The Simple Linear Regression Model**

In this regard, we recall that the equation of a straight line is

\[ Y = B_0 + B_1 X \] \hspace{1cm} (2.1)

Where \( B_0 \) is the \( Y \) intercept and \( B_1 \) is the slope of the line. In simple linear regression, we model the relationship between two variables as a straight line. Thus, our model must contain two parameters namely, the intercept (\( B_0 \)) and the slope (\( B_1 \)).
Now, we wish to obtain good estimators of \( B_0 \) and \( B_1 \). A method that provides us good estimators of the regression parameters is the Method of Least Squares. According to this method, the estimates of \( B_0 \) and \( B_1 \) are denoted as \( b_0 \) and \( b_1 \) respectively. Therefore, the estimated regression line can be written as

\[
y = b_0 + b_1 X
\]  
(2.2)

Here, \( y \) is the estimated value of \( Y \) calculated on the basis of observed set of \( n \) paired data \([(X_i, Y_i) : i = 1, 2, 3 \ldots \ n] \).

At this point of time, it should be recalled that \( b_0 \) and \( b_1 \) in (2.2) are the estimators of the of the regression parameters \( B_0 \) and \( B_1 \) respectively, and, therefore, be defined along with their respective standard errors which are useful in the construction of confidence intervals for, and also in conducting test of hypothesis test for \( B_0 \) and \( B_1 \) respectively.

This is in view of the fact that all the descriptive measures in the regression analysis have been computed and interpreted on the basis of a random sample drawn from the population. Thus, all these measures are subject to sampling error. In other words, in the language of sampling theory, there is always a chance that the sample may provide misleading information due to involved sampling errors. Thus, it is necessary to test the statistical significance of the descriptive measures of the regression analysis. The same can be achieved by formulating the relevant hypothesis.
2.8. Forming Confidence Intervals for the Regression Parameters

Suppose, \( s(b_0) \) and \( s(b_1) \) are the respective standard errors of the estimators \( b_0 \) and \( b_1 \). Then a \( (1 - \alpha) \) 100% confidence interval for \( B_0 \) is:

\[
b_0 \pm t_{\alpha/2} (n - 2) s(b_0)
\]

.........(2.3)

Similarly, \( (1 - \alpha) \) 100% confidence interval for \( B_1 \) is:

\[
b_1 \pm t_{\alpha/2} (n - 2) s(b_1)
\]

.........(2.4)

2.9. Relevant Hypothesis Formulation

In the present case, the three hypotheses are formulated to meet the objective. These are:

1. To test the significance of the population correlation coefficient denoted as \( \rho \)
2. To test the significance of the slope of the regression model.
3. To test the significance of the regression of \( Y \) on \( X \).

2.10. Multiple Regression Model

In regression analysis, often the variable of interest depends on more than just one another variable. There may be several independent variables that contain information about the variable we are willing to predict or understand. In such cases, it may be worthwhile to formulate a model which allows us to consider the relation of our variable of interest with a set of independent variables, when several independent variables are included in a regression equation, our model is called a multiple regression model.
The k Variable Multiple Regression Model

A population regression model of a dependent variable \( Y \) on a set of \( k \) independent variables \( X_1, X_2, \ldots, X_k \) is given by

\[
Y = B_0 + B_1 X_1 + B_2 X_2 + \ldots + B_k X_k
\]

\((2.5)\)

The estimated regression relationship of the population model is

\[
y = b_0 + b_1 X_1 + b_2 X_2 + \ldots + b_k X_k
\]

\((2.6)\)

Here, small \( y \) is the predicted/estimated value of capital \( Y \). The terms \( b_0, b_1, b_2, \ldots, b_k \) are the least square estimates of the respective population regression parameters \( B_0, B_1, B_2, \ldots, B_k \).

The normal equations estimating population parameters for \( k = 2 \) independent variables can be obtained easily by using the method of least squares.

2.11. Statistical Analysis

For the statistical analysis of the regression model we first go for descriptive measures of the regression analysis and relevant hypotheses formulation. This analysis is based on statistical technique which can be divided in the following two classes, namely:

1. Descriptive measures in regression analysis.
2. Testing the statistical significance of the descriptive measures.

Above mentioned statistical techniques will be respectively detailed in the sub-sections 2.12. (a) and 2.12. (b).
2.11. (a) Descriptive Measures of The Regression Analysis

For meeting the objective in the research plan, we have the following 5 (Five) descriptive measures in the regression analysis of the bivariate data (Y, X) which have been obtained and interpreted. The Standard error of estimates have also been interpreted. The descriptive measures of the regression analysis are:

(a) The coefficient of correlation between Y and X.

(b) The coefficient of determination.

(c) The regression of Y on X.

(d) The standard error of estimate in the estimated regression model of Y on X.

(e) \((1 - \alpha)\) 100 \% predictive confidence interval for estimated dependent indices (Nifty & Sensex)

Since all the descriptive measure in the regression analysis have been computed and interpreted on the basis of a random sample drawn from the target Population, these measures are subject to sampling error. In other wards, in the language of sampling theory, there is always a chance that the sample may provide misleading information due to involved sampling error. Thus, it is necessary to test the statistical significance of the descriptive measures of the regression analysis. The same can be achieved by formulating the relevant hypotheses.
2.11. (b) Hypotheses Formulation and Testing

The three null hypotheses which can be formulated to meet the objective are:

(i) $H_0$: To test the significance of the population correlation coefficient.

(ii) $H_0$: To test the significance of the regression of $Y$ on $X$.

(iii) $H_0$: To test the significance of the slope of the developed regression model.

After drawing random samples on 10 (Ten) independent variables, say $[X_i \ (i = 1, 2, 3, \ldots, 10)]$, the investigator obtained descriptive measures for the regression of $Y$ on $X$ for each independent variable. The same have been analyzed and interpreted in chapter 3 and 4.

Descriptive Measures

1. Coefficient of correlation $r$

2. Regression of $Y$ on $X$

3. $r^2$ indicates that $r^2\%$ variations in the dependent variables, $Y$, is explained by the independent variable $X$.

4. An estimate of SEE in the estimated regression model.

5. $(1 - \alpha)\%$ confidence interval for involved parameters.

Once the summary measures in the regression analysis based on sample data have been obtained, there is always a chance that sample may provide misleading information due to involved sampling error. To determine the significance
of these summary measures, we formulate appropriate hypotheses and also list the test statistic for support or refute the hypotheses. Following three null hypotheses have been formulated to meet the objective in the study:

(a) Testing the significance of population correlation coefficient. Corresponding null hypothesis is $H_0: \rho = 0$ against the alternative hypotheses $H_1: \rho \neq 0$.

(b) Testing the statistical significance of the linear regression model between $Y$ and $X$. In this regard the corresponding formulated null hypothesis will be:

$H_0$: The regression model does not explain any of the total variation in the dependent variable.

(c) Testing the statistical significance of the slope of the regression line. The hypothesis formulated in this situation will be $H_0: B = 0$ against an alternative hypothesis $H_1: B \neq 0$. Where $B$ is the slope of the regression line in the population.

While going for the analysis of the data in the framework of regression analysis, one has to be aware about the following measures of the bivariate data.

2.12. Formulating and Testing the Hypothesis

After obtaining the correlation co-efficient and regression model for the sample data set ($Y$, $X$) for all the ten (10) independent variables, we would like to see if the model developed is statistically, significant. For achieving the objective, we formulate and test the following hypothesis in each case.
### ANOVA Table for testing the significance of the fitted regression model

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>S.S.</th>
<th>d.f.</th>
<th>M.S.</th>
<th>F-Ratio</th>
<th>( F_{1, (n - 2)} (0.5) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>SSR</td>
<td>1</td>
<td>MSR = SS/1.0</td>
<td>MSR/MSE</td>
<td></td>
</tr>
<tr>
<td>Unexplained (Error)</td>
<td>SSE</td>
<td>n-2</td>
<td>MSE = SSE/(n-2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>TSS</td>
<td>n-1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **SS** = Sum of squares
- **TSS** = Total sum of square
- **d.f.** = Degrees of freedom
- **MSR** = MS due to regression
- **M.S.** = Mean sum of squares
- **MSE** = MS due to error
- **SSR** = SS due to regression
- **SSE** = SS due to error
- **n** = Number of observations

**Decision Rule**: If \( F > F_{\text{critical}} \), reject \( H_0 \): at the stated level of significance otherwise we do not reject and conclude accordingly.

### 2.12. (c) Testing the Statistical Significance of the Slope of the Simple Regression Model

Let the regression model be \( Y = a + bx \). Then \( a \) is called the intercept and \( b \) is called the slope. In this testing of hypothesis, we test whether the true regression slope is zero. However, since, a slope of 0 (Zero) would imply that the independent variable is of no use in explaining the variation in the dependent variable \( Y \), the testing of null hypothesis discussed, can also be used to test \( H_0 : B = 0 \) against the alternative hypothesis \( H_1 : B \neq 0 \). \( B \) being the slope of the regression model.

The test statistic used for testing the \( H_0 : B = 0 \) is
\[ t = \frac{b}{S_b} \]

Where, \( b \) = the regression slope

\( S_b \) = the standard error of \( b \).

The degrees of freedom for the test are \((n - 2)\).

Hence, acceptance of \( H_0 : B = 0 \) leads to the acceptance of \( H_0 \) that the regression model does not explain any of the total variation in the dependent variable.

Decision Rule: If \( t > t_{\text{critical}} \), Reject \( H_0 \) : at the stated level of significance, otherwise do not reject \( H_0 \) and conclude accordingly.

2.13. Type I and Type II Errors & P-Value

In the context of testing of statistical hypothesis where the decision making is based on the random sample drawn from the population, it is always possible to commit errors. Here, rejecting a true null hypothesis is known as **Type I error** and accepting a false null hypothesis is known as **type II error**. The sizes (or the probabilities) of committing these errors are respectively denoted as \( \alpha \) and \( \beta \). Thus,

\[ \alpha = P \text{ (Rejecting a true null hypothesis.)} \]

\[ \beta = P \text{ (Accepting a false null hypothesis.)} \]

The most common policy in testing a statistical hypothesis is to establish a significance level, denoted by \( \alpha \), and reject \( H_0 \) : when \( P\text{-value} \) falls below it, i.e. \( P\text{-value} < \alpha \). otherwise, we accept it. When this policy is followed, one
can be sure that the maximum probability of type I error is \( \alpha \). The standard values of are 10\%, 5\% and 01\%.

**Important Note**

Here most of the formulas used in the analysis of the estimated Simple/Multiple linear regression model happens to be computationally tedious. However, it was not a cause of worry for the investigator as most of the Statistical Analysis was completed on computer. The computer output from SPSS (Statistical Package For Social Sciences) software provided all the descriptive and inferential conclusions for the specified data in a very short time.