Chapter-4

DATA AND METHODOLOGY

4.1 Selection of Variables

In the literature, numerous macroeconomic factors are considered when attempting to establish the relationship between macroeconomic variables and stock prices. The present study employs data on some selected macroeconomic variables like Index of Industrial Production (LnIIp), Interest Rate (IR), Wholesale Price Index (LnWPI), Exchange Rate (ER) in addition to data on price indices of Bombay Stock Exchange, Sensex, and National Stock Exchange, S&P CNX Nifty. BSE Sensex and NSE Nifty are utilized because these indices represent the whole Indian capital market. The S&P CNX Nifty covers 21 sectors of the Indian economy and the share of trade volume of these indices is more in total traded volume in Indian security market. Moreover, these indices are very general for an ordinary person. BSE and NSE are the largest and most active stock exchanges in India. The selection of relevant macroeconomic variables requires judgment and we draw upon both existing theory and empirical evidence (Chen, Roll and Ross, 1986). Similar dependent variables or macroeconomic variables have been used by Chen, et al. (1986), Shahid Ahmed (2008), Johann Burgestaller (2002), Armi Cooper Maysami, et al. (2004), Ray, et al. (2004).

The present study chooses the four macroeconomic variables vis-à-vis index of industrial production (LnIIP), interest rate (IR), with the expectation that these variables play important role in determining the prices of Sensex and Nifty stocks. Index of industrial production is used as a proxy variable of economic growth which refers to increase in output and national income for the economy. In other words, we can say that economic growth means that increase in a country’s real output of goods and services. It is theoretically shown that the industrial production increases during economic expansion and decreases during recession. Therefore, change industrial production would be an indicator of change in economy. If the productive capacity of an economy is rising, it would be resultant of increase the economic growth. It will contribute to the ability of firms to generate cash flow. Therefore, the industrial production would be expected to act beneficially on expected future cha flow, hence a positive relationship is existed between real economic growth and stock prices. Fama (1981) found that the growth rate of industrial production have a strong contemporaneous relation with stock returns. Shahid Ahmed (2008) revealed that movement in stock prices causes movement in IIP. It clearly implies that stock prices leads real economic activity. It reveals that growth rate of real sector is factored in the movement in stock prices. Ray, et al. (2003) found that consistent relationship between stock prices and industrial production and indicated that economic growth helps to increase the corporate earnings, improving present value of firm and it also increases the national disposable income. Atsuyuki Naka and Tarun Mukherjee (1998) indicate that industrial production is the largest positive determinant of Indian stock prices.

Regarding relationship between interest rate and stock prices it in seen that as the government adjusts key interest rates, the risk-free rate will change. If government increases the key interest rates, the risk-free rate will rise as well. It would result in the higher market rate. Hence, the stock’s target price should fall down due to the required rate of return and vis-a-versa. The impact of interest rate on stock prices has been studied by numerous scholars. Adam et al. (2008) found out that the growth rate is largely negative significant in causing the growth of stock prices. Emrah Orzbay (2009) found a negative relationship between stock prices and interest. If decline the rate of interest, it would be expected that contribution to profitability of firms would be risen by reducing the cost of capital. Therefore, a high interest is expected to have adverse effect on stock prices.

In the present study, WPI is taken as typical proxy variables for inflation rate. Inflation is consistent and appreciable rise in the general price level. It is generally associated with high prices which cause a decline in the purchasing power. According to Pigou, ‘inflation exists when money income is expanding more than in proportion to increases in earning activity’. Milton Friedman wrote about the inflation, ‘Inflation is always and everywhere a monetary phenomenon’. Inflation is the rate of change of general price level, which is computed as the weighted average of general prices index normally reflect the relative importance of the goods and services included and the study uses the general price index of WPI. The general price index captures the overall magnitude of prices of the goods and services. In an equity valuation process, it is important to consider the effects of inflation on stock prices because inflation rates change over time. In literature, we find a negative relationship between inflation and stock prices because an increase in the rate of inflation is accompanied by both lower expected earnings growth and higher required real returns.

Emrah Orzbay (2009) gives a concluding remark that inflation has a negative relationship with stock prices. Similarly, exchange rate is also expected to be negatively related with stock price.

4.2 Data Description:

The present empirical study is based on secondary data that covers the period from April 1994 to June 2010 due to availability of data. The study takes 195 total observations of monthly data for the period. The study utilizes the time-series monthly data on selected dependent variables: BSE Sensex and NSE S&P CNX Nifty and independent variables IIP, IR, WPI and ER. The study utilizes the closing stock prices of BSE Sensex and NSE S&P CNX Nifty indices for set of dependent variables. Interest rate is calculated by monthly average of 91-days Treasury bill. Data on interest rate is obtained from the Handbook of statistics on Indian Economy 2009-10 and monthly bulletin. Index of Industrial Productions used as proxy of output.IIP is a monthly general index (weight 100) of Index of Industrial Production and 1993-94 year is the base year for the index. Data on IIP is obtained from Central Statistical Organization, Government of India. WPI is all commodities Wholesale Price Index with base year 1993-94 which is taken to determine the relationship between stock prices and inflation. Data on WPI is extracted from the Handbook of Statistics on Indian Economy 2009-10. Exchange rate is taken as another key macroeconomic variable which obtained from the Handbook of Statistics on Indian Economy 2009-10. Exchange rate is rate of US Dollar, for instance Rs /$. Some relevant data and information are extracted from the Economic-survey of India 2009-10 and 2010-11.

The brief description for each variable used is presented in table:

Table: 4.1 Description and Sources of Data

Symbol	Concept of Variable	Description	Source
LnBSE	Stock prices	Closing Stock Prices of BSE SENSEX Index	Bombay Stock Exchange Index Statistics

LnNSE	Stock prices	Closing Prices of National Stock Exchange Nifty Index	National Stock Exchange Index Statistics
LnIIP	Index of Industrial Production	Proxy Variable for Output with Base Year 1993-94	Central Statistical Organization, Government of India
IR	Interest Rate	91- day Treasury bill rate	Handbook of Statistics on Indian Economy 2009-10 Published by RBI
LnWPI	Inflation	All Commodity Wholesale Price Index with Based Year 1993-94	Handbook of Statistics on Indian Economy 2009-10 published by RBI
ER	Exchange Rate	Rupees per U.S Dollar Rate	Handbook of Statistics on Indian Economy 2009-10 published by RBI

4.3 Method of Analysis:

The study employs the following methods in order to fulfill the research objectives.

4.3.1 Unit Root Tests

In the literature, I found that time-series data are often assumed to be non-stationary and different price series that used in stock market studies. The stationarity of data is characterized by a time variant mean and variance. Data is said to be stationary if its mean and variance are constant. It is necessary to carry out a univariate analysis to ensure whether a stationary co-integration relationship among variables to avoid the problem of spurious regression before employing the Error Correction Model (ECM). The results will have no economic meaning if that are estimated the relationship without identify the stationarity of data. Unit root tests are performed to test the stationarity of series. The present study employs the Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test to check the unit root of time-series monthly data. These tests are performed to the level variables as well as to their first difference in logarithms term of the series for intercept and trend & intercept model.

4.3.1.1 Augmented Dickey-Fuller (ADF) Test

ADF testis the modified version of Dickey-Fuller (DF) test to determine whether there is a unit root in macroeconomic variables and stock indices used in the study. The ADF test controls for higher-order correlation by adding lagged difference terms of the dependent variable to the right-hand side of the regression[1]. This test is conducted by augmenting the preceding three equations by adding the lagged values of the dependent variable ΔY_t. ADF test is performed to the level and their first difference of the series for two models: first is intercept and second is trend & intercept model. The unit root test has following two equations for intercept and trend & intercepts models.

Intercept Model:

$$\Delta Y_t = \beta_1 + \delta Y_{t-I} + \sum_{i=1}^{m} \alpha_I \, \Delta Y_{t-1} + \varepsilon_t \qquad (1)$$

[1]Damodar N. Gujarati and Sangeetha, Basic Econometrics; p-836

Trend and Intercept model

$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-I} + \sum_{i=1}^{m} \alpha \, \Delta Y_{t-1} + \varepsilon_t$ (2)

Where

ΔY_t is the first difference of the series Y_t

$\alpha_{i,}\beta_1$, β_2 are parameters to be estimated;

t is the time or trend variable;

ε_t is a white noise term.

The ADF tests the null hypothesis (H_0) against the alternative (H_1) hypothesis;

H_0: Each variable has a unit root, $\delta = 0$

H_1: Each variable does not have a unit root, $\delta \neq 0$

4.3.1.2 Phillips-Perron (PP) 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. So when using the ADF methodology, we have to make sure that the error terms are uncorrelated and have constant variance. Phillips and Perron (1988) developed a generalization of ADF test that allows for mild assumptions concerning the distribution of errors. The test regression for PP test is the AR (1) process:

$\Delta Y_{t-1} = \alpha_0 + \beta Y_{t-1} + \varepsilon_t$ (3)

While ADF test corrects for higher or serial correlation by adding lagged differenced termed on the right hand side, the PP test makes correction to the t statistic of the coefficient from AR (1) regression to account for the serial correlation in ε_t.[2]

$$H_0: \beta = 0$$

[2] D. Asterrou,and Palgrave Macmillan, (2006), Applied Econometrics.

$$H_1: \beta > 0$$

The time series model requires to determine the optimal lag length. Akaika Information Criterion (AIC) and Schwarz Information Criterion (SIC) are used in order to determine the optimal lag length. AIC method imposes penalty for adding large number of regressors to model[3]. It is defined as:

$$AIC = e^{2k/n} \sum \hat{u}_i^2 / n = e^{2k/n} RSS/n \quad (4)$$

Where k is the number of regressors including the intercept and n is the number of observations. It is written for mathematical convenience as follow:

$$\text{Ln AIC} = (2k/n) + \ln (RSS/n) \quad (5)$$

Where, ln AIC is the natural log of AIC and $2k/n$ is penalty factor. N is number of observation, RSS is residual sum square.

The SIC criteria is employed as under:

$$\text{Ln(SIC)} = (k/n)\text{Ln}(n) + \text{Ln}(RSS/n) \quad (6)$$

The optimum lag length is determined where the AIC/SIC bear lowest values.

4.4 Co integration and Vector Error Correction Model

In a two variable model, there can be only one co-integrating vector. But when there are more than two variables in a model, the number of co-integrating vectors can be more than one. In fact, for *n* number of variables there can be up to n-1 co-integrating vectors. This problem can not be resolved by the Engle-Granger single equation approach. Since we have five variables in our model, Johansen approach for multiple equations in adopted here. Considering n variables, all of which

[3]Damoda N. Gujarati and Sangeetha,(2007), Basic Econometrics; p-548

can be endogenous, a Vector Auto Regressive model with higher order. Autoregressive process can be written as:

$$X_t = A_1X_{t-1} + A_2X_{t-2} + \ldots\ldots\ldots\ldots\ldots + A_pX_{t-p} + e_t \quad (7)$$

Where

$X_t = (n\times 1)$ vector $(X_{1t}, X_{2t}, \ldots\ldots\ldots\ldots X_{nt})$

e_t = an independently and identically distributed n dimensional vector with zero mean and variance matrix Σ_ε. Equation (1) can be reformulated in a vector error correlation model (VECM) as follows:

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{p-1} \Pi_i \Delta X_{t-1} + \varepsilon_t \quad (8)$$

Where, $\Pi = -(I - \sum_{i=1}^{p-1} A_i)$ and $\Pi_i = -\sum_{j=i+1}^{p-1} A_j$

The important point to note in equation (2) is the rank of the matrix Π, the rank of Π is equal to the number of independent co-integrating vectors. Clearly, it rank of (Π) =0, the matrix is null and equation (2) is the usual VAR model in first differences. If Π is of rank n, the vector process is stationary. Intermediate cases, if rank (Π) = 1, there is a single co-integration vector and the expression Πx_{t-1} is the error correction term. For other cases in which $1 <$ rank $(\Pi) < n$, there are multiple co-integrating vectors.

4.4.1 Cointegrating Tests

Johansen (1988) and Johansen and Juselius (1990) suggest two tests for determining the number co-integrating vectors. In practice, only estimates of Π and its characteristics roots can be obtained. The tests for the number of characteristic roots that are insignificantly different from unity can be conducted using following two test statistics:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{n} ln(1-\lambda_i) \quad (9)$$

$$\lambda_{max}(r, r+1) = -T\ ln(1-\lambda_{r+1}) \quad (10)$$

where, λ_i= the estimated values of the characteristic roots (Eigen values) obtained from the estimated Π matrix.

T = the number of observations

The first statistic tests the null hypothesis that the number of distinct co-integrating vectors is less than or equal to r against the alternative hypothesis that co-integrating vectors is greater than r.

The second statistic tests the null hypothesis that the number of co-integrating vectors is r against the alternative of r+1 co-integrating vectors.

4.4.2 Estimation of Co-integrating Vector and Coefficients of Error Correction

In order to test other restrictions on the co-integrating vector, Johansen defines the two matrices α and β both of dimension $(n \times r)$ where r is the rank of Π. The properties of α and β are such that:

$$\Pi = \alpha \, \beta'$$

It may be noted that β is the matrix of co-integrating parameters and α is the matrix of the speed of adjustment parameters. Due to cross equation restrictions, it is not possible to estimate α and β using ordinary least squares. However, maximum likelihood method, it is possible to (a) estimate VECM model as given in equation (2). (b) Determine the rank of Π, (c) use the most significant co-integrating vectors to form β, and (d) select such that $\Pi = \alpha\beta'$.