CHAPTER-IV
DATA BASE AND METHODOLOGY

In this chapter sources of data and methodology used in the study has been discussed in detail.

DATA COLLECTION

The study mainly covers the period 1980-2005. The data for Total Exports, Manufactured Exports and its four sections- Chemicals, Basic Manufactured Goods, Machinery & Transport Equipments and Miscellaneous Manufactured Goods and their sub sections have been collected from the various sources. Keeping in mind the nature of study, secondary data have been collected. The required data for 147 product groups have been collected from the following sources:

1. Data on aggregate exports, of sections and at 3-digit product level were obtained from UN Comtrade Data, Foreign Trade Statistics of Asia and the Pacific, World Development Indicators, CMIE Foreign Trade statistics. Data on Diversification Index and Concentration Index were obtained from UNCTAD Handbook of Statistics, UN.

2. Data on Quantum Index of Exports, Unit Value Index of Exports and Imports were obtained from various issues of Report on Currency and Finance, Reserve Bank of India, Statistical Annual Year Book, U. N. and International Financial Statistics, I.M.F.

3. Data on Gross National Product, Exports and Imports, were obtained from various issues of World Development Indicators and Economic Survey, Government of India.

4. Data on labour cost and wages have been collected from Annual survey of Industry. Data on R & D expenditure have been obtained from
Research and Development Statistics and Handbook of Industrial Statistics.

METHODOLOGY

At global level following eight measures of competitiveness have been used:

(i) Export-GDP Ratio
(ii) Trade-GDP Ratio
(iii) Trade Balance-GDP Ratio
(iv) Export-Import Ratio
(v) Trade Balance-Total Trade Ratio
(vi) Hirschman Index of Concentration
(vii) Herfindhal-Hirschman Index of Diversification
(viii) Intra-Industry Trade (IIT) Index

Herfindhal-Hirschman Index of Concentration

The Herfindhal-Hirschman index (HHI) is among the most widely accepted measures of the degree of market concentration. HHI serves as a measure of competitiveness. It has been normalized to obtain values ranking from 0 to 1 (maximum concentration), according to the following formula:

\[ H_j = \frac{\sqrt{\sum_{i=1}^{n} \left( \frac{x_i}{x} \right)^2} - \sqrt{\frac{1}{n}}}{1 - \sqrt{\frac{1}{n}}} \]

\[ H_j = \text{country index with value ranging from 0 to 1 (maximum concentration)} \]

\[ x_i = \text{Value of exports of products i} \]
\[ x = \sum_{i=1}^{n} x_i \text{ and } n = 239 \text{ number of products (at the three-digit level of SITC, Revision 2)}. \] Numbers of products exported include only those products with value greater than $100,000 or which constitute more than 0.3 percent of the country’s total exports (UNCTAD Handbook of Statistics, 2005).

**Hirschman Index of Diversification**

Diversification index reveals the extent of differences between the structure of trade of a country and the world average. More is the value of index; more are the differences between export structure of a country and the world export structure. Less is the value of index; less is the differences between export structure of a country and the world export structure. The Export Diversification Index assigns a value of zero to the most diversified economies and a value of one to the least. The index value is calculated by measuring the absolute deviation of the country share from world structure as follows:

\[
S_j = \frac{\sum |h_{ij} - h_i|}{2}
\]

Where \( h_{ij} \) = share of a commodity \( i \) in total exports of country \( j \).

\( h_i \) = share of commodity \( i \) in total world export (UNCTAD Handbook of Statistics, 2005).

**Grubel-Lloyd Index**

Intra-Industry trade, as a measure of competitiveness, has been calculated by measuring Grubel-Lloyd Index as follows:

\[
GL(IIT) = 1 - \frac{|X_i - M_i|}{(X_i + M_i)}
\]
Where $X_i$ and $M_i$ are the value of export and import of section $i$. GL is the IIT index. It is clear that intra-industry trade is the proportion of trade that is not inter-industry. If there is no intra-industry trade, one of $X_i$ or $M_i$ will be zero so that the IIT index will be zero. Similarly, if all trade is intra-industry, $X_i=M_i$ and hence the IIT index will be equal to 1 and $0 < GL \leq 1$ (Kalbasi, H. 2003).

**Spearman’s Rank Correlation Coefficient**

Spearman’s Rank correlation coefficient has been used to know about improvement in competitiveness of product groups and change in the position of country in the world. If value of correlation coefficient increases, it shows improvement in the position of countries (or improvement in competitiveness of product groups). If value of correlation coefficient decreases, it shows adverse impact on the position of countries (or decrease in competitiveness of product groups). Spearman’s Rank correlation coefficient has been calculated by using following formula.

$$R = 1 - \frac{6\sum D^2}{n^3 - n}$$

Where $R$ is rank correlation coefficient

**Factor Analysis**

To examine the contribution of the different variables in export competitiveness of the different countries, Factor Analysis was used. In Factor Analysis, a given set of $n$ variables is grouped into $p$ number of groups called ‘Factor’ which are less in number than the set of original variables. The variables within a group (Factor) are of the same nature or are complementary with respect to the phenomenon under study but between two groups ‘Factor’ variables are independent. Thus factors $F_i$ and $F_j$ are orthogonal.
The data was first normalized using Nagar-Basu (2002) methodology. The selected variables were normalized by subtracting the minimum value of the particular variable from its actual value and dividing it by the range, which is the difference between the maximum and minimum value of the selected variables. The formula is given below:

\[ Z_{ij} = \frac{ActualValue_{ij} - MinimumValue_{ik}}{MaximumValue_{ik} - MinimumValue_{ik}} \]

Where, \( Z_{ij} \) = Normalized value of \( i^{th} \) variable for \( j^{th} \) country;

\( i = \) variable;

\( j = \) country;

\( k = \) specific value.

The technique of Factor Analysis is given as under;

\[ X = LF + U \]

Where \( X \) is vector of all the original variables.

\[ X' = [X_1 + X_2 + X_3, \ldots, X_n] \]

\( F \) is vector of ‘Factor’ derived

\[ F' = [F_1, F_2, F_3, \ldots, F_p] \]

\( U \) is vector of error terms

\[ U' = [E_1, E_2, E_3, \ldots, E_n] \]

And \( X' \), \( F' \) and \( U' \) are the respective transposes.

\( L \) is matrix of Factor Loading (Loading Coefficient Matrix)
The coefficient (Factor Loading) $a_{ij}$ belongs to $i^{th}$ variable and $j^{th}$ factor which is similar to simple correlation coefficient and shows the extent to which variable $X_i$ is related to $F_j$ Factor. “A salient loading is one which is sufficiently high to assume that a relationship exists between the variable and the Factor. In addition, it usually means that relationship is high enough so that the variable can add aid in interpreting the factor and vice-versa.” (Gorsuch, 1974)

The sum of the square of factor loadings of $X_i$ original variables under the derived $p$ Factor is called the communalities ($C_i$) for $X_i$ variables.

$$(a_{i1})^2 + (a_{i2})^2 + (a_{i3})^2 + \ldots + (a_{ip})^2 = (C_i)^2$$

Communality in Factor Analysis is something like $R^2$ in the Regression Analysis and it shows the extent to which the derived factors explain the $i^{th}$ variables. Derived communality value generally should be larger (more than 70 percent) to be sure that each variable has been explained well. By definition, the communality of a variable is that proportion of its variance which can be accounted for the common factors (Lindeman et. Al., 1980).

The principal Component Analysis (Factor Analysis) produces components (Factors) in descending order of their importance and factor loadings which explain the relative importance of different variables in explaining variance in the phenomenon. Some studies using ‘Factor Analysis’ adopted ‘First Principle Component’ as guiding principle for
determining individual indicator weights. In the present study, all the ‘Principle Components’ (Factor derived) are taken into account to determine relative weights of selected variables so as to reflect maximum possible variations in the export competitiveness. The method for determining the relative weights for the variables is explained below:

\[ W_i = F_{ik} \lambda_k \]

Where,

- \( W_i \) = Weight of \( i^{th} \) variable
- \( F_{ik} \) = Factor loading of \( i^{th} \) variable and \( k^{th} \) factor which reflects the highest correlation between variable \( (X_i) \) and factor \( (F_k) \)
- \( \lambda_k \) = variation explained by \( K^{th} \) factor

The weights for the variable determined by applying above mentioned technique are in accordance with the contribution made by the variable in the inter-country variations.

**Composite Index**

The statistical technique employed to develop the weighted composite index involves finding out the ‘Principle Components’ of the groups consisting of these selected 12 variables and derive the implicit weights based thereon. The composite index is then constructed by combining various indicators whose implicit weights are already determined through the technique of ‘Principle Component Analysis’ (Hagood, (1943), Aldeman & Morris, 1967)).

\[
\text{Composite Index for } i^{th} \text{ country} = \frac{\sum W_i Z_{ij}}{\sum W_i}
\]

Where, \( Z_{ij} \) = Normalized value of the \( i^{th} \) variable for the \( j^{th} \) country.
Measures of Competitiveness for India

To measure competitiveness of India, indicators like Balassa’s Trade Index, Balassa’s Revealed Comparative Advantage Indices, Adjusted Grubel-Lloyd Index (Intra-industry index), Hirchman Index of Concentration, Shift-share method, Net Barter, Gross Barter and Income Terms of Trade have been calculated. Growth rates of manufactured exports of India at disaggregate level have also been calculated.

a) Balassa Revealed Comparative Advantage Index (RCAI)

Revealed Comparative Advantage Index (RCAI) is one of the most applied tools to measure the export competitiveness of a manufacturing sector. Developed by Balassa (1965, 1979), the RCAI is defined as a ratio of the share of particular industry (or product) in a country’s total exports to the share of the industry’s exports in world’s total exports. Thus, the \((RCAI_i)^a\) can be presented as:

\[
(RCAI^i)_a = \left(\frac{X_i^a}{X^i} / \frac{X^w_a}{X^w}\right)
\]

Where

\(X_i^a =\) value of exports of commodity \(a\) by country \(i\)
\(X^i =\) value of total exports by country \(i\)
\(X^w_a =\) value of world exports of commodity \(a\)
\(X^w =\) value of total world exports

A country has a revealed comparative advantage only in those products for which its market share of world exports is above its average share of world exports, i.e., if RCAI is greater than one. If RCAI is less than
unity, the country is said to have a comparative disadvantage in the commodity / industry (Mahmood A. 2000).

b) Balassa Trade Index

Balassa trade index is the ratio of net trade to total trade, which has been used to measure competitiveness. Balassa Trade Index is given by:

\[ B = \frac{X_{kt} - M_{kt}}{X_{kt} + M_{kt}} \]

where \( B \) is the Balassa Trade Index, \( X_{kt} \) and \( M_{kt} \) denote exports to and imports of commodity \( k \) at time \( t \) respectively. The value of index lies between \(-1 \leq B \leq 1\). A highly positive (negative) value indicates a comparative advantage (disadvantage) for the domestic country relative to its trading partners (Arghyrou M.G. and Bazina E., 2003).

c) Commodity Concentration Index

A country whose exports of manufactured goods are concentrated in a few products tend to be less competitive than countries with more diversified export structures. A commodity concentration index, in which zero represents the most diversified and one the least diversified exports. In order to measure commodity concentration of exports, we used Hirchman Index of Concentration, which is defined as:

\[ \text{COM}_x = 100 \sqrt{\sum_{i=1}^{n} \left( \frac{X_{it}}{X_t} \right)^2} \]

Where \( \text{COM}_x \) = Commodity Concentration Index.

\( X_{it} \) = Value of exports of ith section in year \( t \)
\[ X_t = \text{Value of total exports in year } t. \]

Four sections have been considered to calculate \( \text{COM}_x \)

**d) Growth Rates**

To analyse the competitiveness of Indian exports at disaggregate level on the basis of growth rates, compound annual growth rates were worked out for the three periods of time i.e. 1980-90 (pre-reform period), 1992-2005 (post-reform period) and 1980-2005 (whole period). The positive and increasing value of growth rates shows increase in competitiveness, while the negative and decreasing value of growth rates shows decrease in competitiveness. Compound annual growth rates have been calculated by using following formula:

\[
Y = AB'
\]

Where \( Y = \text{value of exports of commodity} \)

\[
\text{Growth rate} = (\hat{B} - 1) \times 100
\]

\( t = \text{time period} \)

**e) Terms of Trade:** To measure the competitiveness of Indian exports at disaggregated level, Net Barter, Gross Barter and Income Terms of Trade have been calculated for the three periods of time i.e. 1980-90, 1990-2000, and 1980-2005 by using following indices:

(i). **Net Barter Terms of Trade:** Commodity Terms of Trade or Net Barter Terms of Trade is the ratio of the export prices and import prices. The increasing value of net barter TOT shows terms of trade are favorable for country, hence gain in trade/competitiveness; the decreasing value of TOT shows terms of trade are unfavorable for country, hence loss in trade/competitiveness.
Here, \( T_c \) = commodity terms of trade or net barter terms of trade,

\[
T_c = \frac{P_s}{P_m} \times 100
\]

where, \( P_s \) = index of export price,

\( P_m \) = index of import price.

(ii). Gross Barter Terms of Trade: Gross Barter terms of trade is the ratio of quantity of imports and quantity of exports. The increasing value of gross barter TOT shows terms of trade are favorable for country, hence gain in trade/competitiveness, the decreasing value of TOT shows terms of trade are unfavorable for country, hence loss in competitiveness.

\[
T_g = \frac{Q_m}{Q_s} \times 100
\]

Here, \( T_g \) = gross barter terms of trade,

\( Q_m \) = Quantity index of imports and

\( Q_s \) = Quantity index of exports.

(iii). Income Terms of Trade: The increasing value of Income TOT shows terms of trade are favorable for country, hence gain in trade/competitiveness, the decreasing value of TOT shows terms of trade are unfavorable for country, hence loss in trade/competitiveness. Income terms of trade can be calculated by using following formula:

\[
T_i = \frac{P_s Q_s}{P_m} \times 100
\]

Here, \( T_i \) = Income terms of trade,

\( P_s \) = Index of export price

\( P_m \) = Index of import prices
\( Q_i \) = Quantity index of exports.

**Constant Market Share Method**

Constant-market-share-modal (CMS) has been used for assessing the export competitiveness. For this, we define the following:

\( X^0_{ij} \) = the value of Indian’s export of commodity \( i \) to market \( j \) in base year,

\( X^1_{ij} \) = the value of Indian’s export of commodity \( i \) to market \( j \) in terminal year

\( X^0_i, X^1_i = \) Total export of \( i^{th} \) commodity in the base year and terminal year respectively;

\( r = \) Percentage change in total world export;

\( r_i = \) percentage change in world exports of the \( i^{th} \) commodity;

\( r_{ij} = \) percentage change in world exports of the \( i^{th} \) commodity to the \( j^{th} \) market.

The total change, \( \Delta x \), in exports is given by

\[
\Delta X = \sum (X^1_i - X^0_i)
\]

This can be written as:

\[
\Delta X = r \sum_{i=1}^n X_i + \sum_{i=1}^n (r_i X_i - rX_i) + \sum_{i=1}^n \sum_{j=1}^m r_{ij} X^0_j - \sum_{i=1}^n r_i X^0_i + [\sum (X^1_i - X^0_i) - \sum_{i=1}^n \sum_{j=1}^m r_{ij} X^0_j]
\]
I. World Trade Effect = \(\sum_{i=1}^{n} rX_i\)

II. Commodity Composition Effect = \(\sum_{i=1}^{n} (r_iX_i^0 - rX_i^0)\)

III. Market Distribution Effect = \[\left\{\sum_{i=1}^{n} \left[\sum_{j=1}^{m} r_jX_{ij}^0 - \sum_{j=1}^{m} r_jX_{ij}\right]\right\}\]

IV. Competitiveness Effect = \[\left\{\sum \left(X_i^0 - X_i^0\right) - \sum_{i=1}^{n} \sum_{j=1}^{m} r_jX_{ij}\right\}\]

World Trade Effect = \(\sum_{i=1}^{n} rX_i\)

where, ‘\(X_i\)’ is the export of \(i\)th commodity group of a focus country at the base year, ‘\(r\)’ is the percentage increase of total world exports between two points of time, and ‘\(n\)’ represents the number of export items.

Commodity Composition Effect = \(\sum_{i=1}^{n} (r_iX_i^0 - rX_i^0)\)

In the second stage, the export growth of the reference country is decomposed into the commodity composition effect, which is described in the following form:

\[\sum_{i=1}^{n} (r_iX_i^0 - rX_i^0)\]

where, \(r_i\) is the percentage increase of world export of the commodity group \(i\), between two time periods. If an increase of exports by a country is more than the world average in the similar commodity classes, the sign of commodity composition would be positive and vice versa. A positive sign indicates that the export country had concentrated on export commodities whose markets were growing relatively fast.
Market Distribution Effect = \left[ \sum_{i=1}^{n} \sum_{j=1}^{m} r_{ij}X_{ij} - \sum_{i=1}^{n} r_{i}X_{i} \right]

In the third stage, the export growth of the country is then disaggregated into the market distribution effect, defined as:

\left[ \sum_{i=1}^{n} \sum_{j=1}^{m} r_{ij}X_{ij} - \sum_{i=1}^{n} r_{i}X_{i} \right]

where, \( r_{ij} \) is the percentage increase of the world export of the commodity group \( i \) in the \( j \)th market between two points of time. The number of foreign markets is denoted by ‘m’. A positive sign indicates the ability of the reference country to increase its exports of similar commodity classes in the relatively growing markets. A negative sign suggests that the exports are concentrated in relatively stagnant markets.

Competitiveness Effect = \left[ \sum_{i=1}^{n} (X_{i}^{1} - X_{i}^{0}) - \sum_{i=1}^{n} \sum_{j=1}^{m} r_{ij}X_{ij} \right]

At the final stage the residual, competitiveness effect is derived. A negative sign means that the country fails to maintain its market share because of a lack of competitiveness. This residual term indicates the improvement or deterioration in overall export competitiveness. It is possible that the Competitiveness Effect may provide a biased measure of general competitiveness. For example, in a fast growing export market the country may experience a declining share even with rising exports if it cannot cope with export growth in the market. The net effect will be reflected in the negative sign of the competitiveness effect because of a favourable market and commodity growth. (Ray, Dilip Kumar, 1991; Muhammad, Akbar, 2000; kellman, 2003)

Determinants of International Competitiveness of India

To examine the determinants of international competitiveness of India, Multiple (step-up) regression analysis for total manufactured export of India and its four sections have been carried out for the period 1980-2005.
Multiple (Step-wise) Regression Analysis/Step-up (Forward) Regression Analysis

The specific variables, which were considered as determinants of different categories of exports are given below:

1. **Export Profitability Index (EP)** - The ratio of export unit value index to domestic wholesale price index capture the profitability of exports. Export unit value indices and domestic wholesale prices indices were taken with base 1993-94=100.

   \[ EP = \frac{UVX_i}{WPI_i} \]

   \[ EP = \text{Export Profitability Index} \]
   \[ UVX_i = \text{Unit Value Index of Exports of commodity i of India} \]
   \[ WPI_i = \text{Wholesale price Index of commodity i of India} \]

2. **Relative Export Prices (REP)** - Relative Export Prices measure the degree of price competitiveness and represents competition between foreign and domestic markets. This variable is measured by the ratio of country’s export unit value index to world export unit value index. In order to measure relative price for aggregate exports, we took ratio of India’s export unit value index to world’s export unit value index.

   \[ REP = \frac{UVX_i}{UVX_w} \]

   \[ REP = \text{Relative Export Prices} \]
   \[ UVX_i = \text{Unit Value Index of Exports of India} \]
   \[ UVX_w = \text{Unit value Index of Exports of World} \]

3. **Unit Labour Cost (ULC)** - Unit Labour Cost can be computed by dividing employer labour costs (payments made directly to workers plus employer payments into funds for all benefit of workers) by real value added output
(Gross output less the value of intermediate consumption less depreciation). It is quotient of total labour costs and real output. Gross value added is obtained by subtracting

\[ ULC = \frac{Employer \text{ labour costs}}{Real \text{ value added output}} \]

(Bureau of Labour Statistics and OCED)

4. **Share in Total R&D Expenditure [share (RD)]** - Share of R & D expenditure in total R&D expenditure for each manufacturing section is calculated.

\[ Share(RD) = \frac{R \& D \text{ expenditure of Section}}{Total \ R \& D \text{ Expenditure}} \]

5. **Share of R&D Expenditure in Output** - Share of R&D expenditure in output is also calculated in the following way:

\[ Share(RD/O) = \frac{R \& D \text{ expenditure of Section}}{Total \ Output \ of \ Section} \]

6. **Real Effective Exchange rate (REER)** - This exchange rate is used to determine an individual country's currency value relative to the other major currencies in the index, as adjusted for the effects of inflation. Appreciation of the REER indicates adverse affect on competitiveness, while depreciation of REER indicates favorable affect on competitiveness.

7. **Exchange Rate in terms of SDRs** - The exchange rate is simply the price of one country's currency expressed in another country's currency. In other words, the rate at which one currency can be exchanged for another. Exchange rate depreciation would stimulate exports and curtail imports;
hence improvement in competitiveness, while exchange rate appreciation would be detrimental to exports and encourage imports.

**Correlation Analysis**

In order to study the inter-correlations amongst different determinants of manufactured exports, correlation matrices were constructed. To test, the significance of correlation coefficients, t-test has been applied.

\[ t = \frac{(r_{ij})}{\sqrt{1-(r_{ij})^2}} \sqrt{n-2} \]

Where ‘n’ is the number of observation (i.e. no. of years) and \( r_{ij} \) is the correlation coefficient between ith and jth variables.

**Multiple (Step-up) Regression Analysis**

The major problem likely to be faced in the multiple linear regression analysis is that of multicollinearity. In order to overcome the problem of multicollinearity, step-wise forward regression analysis technique has been used.

The equation for multiple (step-wise) regression analysis can be written as follows:

\[ Y = a + bx_1 + cx_2 + dx_3 + ex_4 + fx_5 + gx_6 + hx_7 \]

It is hypothesized that b, e, f and h > 0

and c, d and g < 0

Where Y is dependent variable (share of exports to output). The co-efficient are a, b, c, d, e, f, g, h. a is the intercept which gives the autonomous change in Y (the dependent variable). The other co-efficient give the change in for the unit change in the corresponding independent variables \( x_1, x_2, x_3, x_4, x_5, x_6, x_7 \) respectively.

\( x_1 = \) Export Profitability
\[ x_2 = \text{Relative Export Prices} \]
\[ x_3 = \text{Unit Labour Cost} \]
\[ x_4 = \text{Share in Total R & D Expenditure} \]
\[ x_5 = \text{Share of R & D in Output} \]
\[ x_6 = \text{Real Effective Exchange Rate (REER)} \]
\[ x_7 = \text{Exchange Rate in terms of SDRs} \]

To compare the explanatory power of different sets of multiple regression equation adjusted coefficients of determination \( (R^2) \) has also been calculated for each regression equation.

\[
\bar{R} = 1 - \left[ \frac{(n - 1)}{(n - k)} \{1 - R^2 \} \right]
\]

Explanatory variables were entered in the stepwise forward regression model in accordance with the correlation with the dependant variable and also taking into account the collinearity as well as explanatory power in view. To estimate the relative contribution of such variables, different combination of these explanatory variables were tried. The results obtained through the regression analysis were interpreted accordingly.