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Chapter III

Methodology

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Introduction

The economic liberalisation measures introduced in India have significant bearing on the growth of the economy and its structure, especially on the industrial structure. Most important prerequisite for any serious analysis of the underlying dynamics is the existence of a consistent and accessible database. Further the nature and content of data requirement in a liberalised regime is different from that in a regulated regime. This is because of greater integration of the economy with the rest of the world and the consequent strengthening of linkages between different aspects related to domestic and external sectors of the economy. Data source and methods used for the present study are given in this chapter.

3.1 Data Source

The present study mainly used secondary data for the analysis. The period of study is mainly from 1980-2002. Different data sources available at national and international levels on trade and related variables used for the present analysis are examined in this section. The availability, coverage and limitations of these data source are also explained. The data source is divided as the international and national level.

3.1.1 International Trade Data Source

United Nation's Trade Data (UN TRADE DATA)

An important source, which gives data on international trade, is the UN trade database. The UN data on trade flows are available from two different volumes of its publication titled 'International Trade Statistics Year Book' volume 1 subtitled as 'Trade by country' and volume 2 'Trade by Commodity'. The quantity and value in US dollars of imports and exports of commodities by countries are given in volume 2. The data for majority of countries from 1962, are
also available in electronic format. The major limitation of the UN data are i) it
did not report exports or imports for those commodities whose share in the total
is less than 0.3 per cent and ii) time lag is involved in making the data available

*Commodity Trade Statistics (COM TRADE)*

This is published by the UN trade statistics division, which collects data
from individual countries. The data is available from 1960 onwards and at
various level classification like Harmonised system (HS), SITC revision

*IMF Direction Of Trade (DOT) Statistics*

IMF Direction of Foreign Trade Statistics Year Book prepared by the
General Economy Division of the Bureau of Statistics is the most relevant and
widely used international trade database for the bilateral trading data. The
yearbook gives 7 years of data for 186 countries along with world and area
summaries. The classification distinguishes three main categories of countries
like industrial countries, developing countries and a group of countries
summarized as other countries. The electronic database of the same publication is
also available.

*UNCTAD Trade Statistics*

Another international publication on trade is a) UNCTAD Trade and
Development statistics renamed as UNCTAD Hand Book. The UNCTAD
handbook of statistics provides a comprehensive collection of statistics relevant
to the analysis of world trade, investment and development. The Hand Books,
which is largely based on existing national and international data sources
provides the unique compilation of data through the use of rank ordering, growth
rate, shares and other special calculations so as to facilitate the interpretations.

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1 International Trade Statistics Year Book, United Nations, Department of Economic and Social

2 Direction of Trade Statistics Year Book, International Monetary Fund, Washington D.C.
Data are divided into seven parts. Part one of the publication includes value; growth and share of world trade in current price, trade balance, intra trade by region and trade in services. Part two covers volume, unit value and terms of trade indices; part three covers network of world trade summary by selected region of origin and destination and exports and imports structure by selected commodity groups. Exports and imports structure by commodity groups and by country is included in the fourth part. Part fifth consist of Balance of Payment, Foreign Direct investment, financial flows etc. Basic indicators of development are included in the next part and some special statistics in the seventh part.

*World Trade Organization Trade Statistics*

The World Trade Organisation also publishes data on trade, GNP, production, Tariff level and foreign direct investment. The data is available in electronic database format.

*Trade and Production Data Base*

This database contains trade, production and tariff data for 67 developing and developed countries at the industry level over the period from 1976. The sector disaggregation in the database follows the International Standard Industrial Classification (ISIC) and is provided at 3 digit levels (28 industries) for 67 countries and at the 4 digit level (81 industries) for 24 of these countries. The source of trade database is United Nations Statistics Departments, which collects data from individual countries and then reports the data in the Commodity Trade Statistics (COMTRADE) database and it includes imports, exports and mirrored exports (i.e., exports calculated using import data reported

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4 The sources of production data are the CD-ROM version of UNIDO's Industrial Statistics database at the 3 and 4-digit level of ISIC classification. It include data on value added, total output, average wages, capital formation, number of employees and the number of firms. The sources of MFN average tariffs are the UNCTAD's Trains database and WTO's Trade Policy Reviews and Integrated Data Base (IDB)
by partner countries). Trade data is aggregated by region and income levels according to World Bank definition. A separate data set is provided on bilateral trade flows (by partners) at the industry level. The ISIC database is created by transforming the SITC Rev.2 classification. The concordance table developed by OECD, which provides two slightly different concordance tables: one for exports and another for imports. The major problems of the Trade and Production database are the presence of the label ‘not classified’ as a partner. This is the case when the country does not know or does not disclose the origin or the destination of trade flows. In the Trade and Production database, data on not classified countries are not allocated to any particular region but are reported as separate observations as ‘not classified’ value result as negative due to concordance aggregation between the SITC and the ISIC classification. In this case negative value is split across all regions according to weights calculated on the basis of existing documented trade. This problem affects only minimal parts of the data and is equivalent in assuming that exports or imports not classified by country of destination or origin are distributed to each region using as weights the documented trade flows.

3.1.2 Indian Trade Data Sources

Major source of official data on Indian trade flows are the publications of (i) Reserve Bank of India (ii) Director General of Commercial Intelligence and Statistics (DGCI&S) apart from the above sources. The Director General of Foreign Trade (DGFT) is responsible for licensing statistics, the Reserve Bank of India (RBI) for the balance of payment statistics and the DGCI&S for the balance of trade statistics in India.

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5 The table do not follow a one to one correspondence, but matching is done through a method of estimated weights. The trade and production database is balanced and report values for imports and exports

Reserve Bank of India

The RBI statistics is based on the merchandise transaction taking place in the economy, which is valued at the actual price paid through the banking channel, where export figures are on the basis of declarations and imports are on the basis of realisation rather than on landed merchandise. As the major purpose of the RBI data is to provide information on the balance of payment situation in the country, it is not available at different levels of disaggregation.

Director General of Commercial Intelligence and Statistics (DGCI&S)

The DGCI&S provides the most comprehensive and up to-date data on India’s foreign trade. The data include information on value, quantum and value of exports and imports both country and commodity wise. This statistics is based on customs clearance of merchandise transaction at major parts of the country. Export statistics are based on declaration made by importers in bills of entry, both being subsequently checked by custom authorities, furnish these data to DGCI&S.7

The two major publications of the DGCI&S are (i) Monthly statistics of Foreign trade of India (MSFTI) (commodity-Country) - Volume one of MSFTI includes Exports and Re-Exports and Volume two Imports. (ii) Statistics of Foreign trade of India (SFTI) by Countries (Country- Commodity) Volume one of SFTI includes Exports and Re-Exports and Volume two Imports (Quarterly). March issue of these publications gives annual data. Volume I, that is, the export data of MSFTI has been split into two parts from April 1998 onwards, with part one containing (Harmonised system) chapters 1-49 and the remaining chapters in

7 The shipping bills and bills of entry for each item of export and import contains all relevant details of the transactions, such as I) code number of the commodity, II) description of the codes, III) Licence particulars of the goods in case of imports IV) value of export/import V) Quantity (Gross and net) VI) amount of duty VII) name of exporter/ importer and VIII) Country of consignment / origin and destination
part two. There are two parts for SFTI export Volume also, part one containing countries starting with English alphabet A to M and part two N to Z.

Unlike the RBI, DGCI&S provides data at a highly disaggregate level. The DGCI&S has adopted a new commodity classification system known as the Harmonised system (HS) from April 1987.

**Table 3.1**

Classification of Trade Data

<table>
<thead>
<tr>
<th>Years</th>
<th>UN Classification</th>
<th>Indian Classification</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1957 to March 1965</td>
<td>Standard International Trade Classification (SITC)</td>
<td>Indian Trade Classification (ITC)</td>
<td>10 broad sections</td>
</tr>
<tr>
<td>April 1965 to March 1977</td>
<td>Standard International Trade Classification-Revised (SITC-R)</td>
<td>Revised Indian Trade Classification (RITC)</td>
<td>SITC-R 5 digits RITC 7 digits, subdivided into 184 groups</td>
</tr>
<tr>
<td>April 1977 to March 1987</td>
<td>SITC-Revision 2</td>
<td>Indian Trade Classification - Revision 2 (ITC-R2)</td>
<td>ITC-R2 7 digits, total number of Commodities are 7088</td>
</tr>
<tr>
<td>April 1987 to December 1995</td>
<td>Harmonised System (HS)</td>
<td>ITC (HS)</td>
<td>2-digit chapters (97) 4-digit HS headings (1253) 6-digit HS subheadings (5063) 8-digit commodity classification</td>
</tr>
<tr>
<td>(February 1986 Onwards for tariff)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January 1996 Onwards</td>
<td>Revised HS</td>
<td>Revised ITC (HS)</td>
<td>As above, with changes in some Sub-headings. 10,839 commodities at the 8-digit level</td>
</tr>
</tbody>
</table>

Source: Mihir Pandey, 2004

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The classification consists of 99 chapters (including chapter 77 reserved for future use) represented by 2-digit codes, 1253 HS heading represented by 4-digit codes and 5062 HS subheading represented by 6-digit codes. The 8-digit codes of HS nearly 17035 in number have been derived by further sub division of 5062 HS sub heading to capture data on commodities of national importance. Manual handling of such a vast body of data is laborious. Now the data pertaining to the above two publications available in an electronic database. 'India Trade' supplied by Centre for Monitoring Indian Economy (CMIE) since 1995.\textsuperscript{9} Trade data is available according to the Indian Trade Classification [ITC (HS)] based on the harmonised Commodity description and Coding System. Earlier the data was based on the United Nations Standard International Trade Classification (SITC). The changes in the classification of trade data is shown in Table 3.1.

The DGCI&S data is preferred among the available other sources due to the following reason. First it is the most comprehensive and up to date official statistics on India's trade flows. Second it is available at a reasonable time lag, particularly with the introduction of electronic database. Third it is possible to match the trade classification followed by DGCI&S with the NIC and a concordance table is provided by Debroy and Santhanam (1993)\textsuperscript{10}.

\textbf{Data on Industrial Characteristics}

There are two sources of data for industrial production. One is the Index of industrial production (IIP) and the other is National Accounts Statistics that is based on ASI data. While the IIP is available at monthly intervals, the NAS is

\textsuperscript{9} The DGCI&S data appears to be the preferred one among the available sources, because of the following consideration 1) it is the most comprehensive and up-to-date official statistics on India's trade flows 2) this data are available to the users with a reasonable time lag particularly so with the introduction of the electronic database 3) it is possible to match the trade classification system followed by the DGCI&S with the NIC and a concordance table is provided by Debroy and Santhanam.

published annually, but with a longer time lag. The IIP is available for 18 two-
digit industry groups, as well as five use-based, three input-based and two sector-
based categories. The source of the data used for the index is voluntary reporting
of monthly output by firms with equipment investment of over Rs. 20 lakh in
1980. Small-scale firms are included in those industry groups where they
dominate. The IIP is revised every ten years. The index is, however, plagued by
incomplete coverage, and does not cover the unregistered manufacturing sector
at all.

Annual Survey of Industries (ASI)

For the purpose of collection of data on manufacturing, industrial activity
in the country is divided into factory (registered or organised) and non-factory
(unregistered or unorganised) sectors\(^1\). The most comprehensive official data
source on production statistics of the factory sector is the ASI brought out
annually by Central Statistical Organisation\(^2\). The ASI has been conducted since
1959 at the authority of collection of Statistics ACT 1953. The primary unit of
enumeration is the factory and the reference period is the accounting year of the
factory ending on any day during financial year. From 1987-88 onwards a new
sampling design has been adopted, according to which, factories employing 100
or more workers whether using power or not constitute the Census sector. The
remaining factories constitute the non-census (sample) sector. Also from 1987-

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\(^1\) The ASI replaced both the Census of Manufacturing Industries (CMI) and the Sample Survey of
Manufacturing Industries (SSMI), which were the main official industrial statistics till 1958. The
CMI gave information by type of ownership\(^4\) at the aggregate level, that is, for the entire
manufacturing sector for the years 1951 to 1958. Variables for which information was available
included productive capital, persons employed, salaries, wages and benefits to employees, gross
output, materials consumed, and value added. Since 1954, this information was given at the
industry level. This was, however, available only up to the year 1958. One major drawback of this
data source was that it did not distinguish between government and non-government companies. It
also did not distinguish between workers and salaried-class.

\(^2\) The factory sector covers units registered under the factory Act 1998. The non-factory sector
consisted of household and non-household industrial units, which are not registered under the said
Act.
88 a stratified uni-stage sampling design has been adopted for the sample sector and the coverage of the census sector has been reduced.

From 1989-90 onwards, NIC 1987 is followed for classification of industries. All the factories in ASI are accordingly classified in the appropriate industry group on the basis of value of the principal product manufactured by them. Therefore units get classified as one and only one industry group even though it might be manufacturing products belonging to different industries. The NIC 1987 is based on the international system devised by UN in its International Standard Industrial Classification (ISIC) 1968 Revision\textsuperscript{13}. The classification consisted of 24 items at 2-digit level, 196 items at 3-digit level and 288 items at 4-digit level.

Major publications of the Central Statistical Organisation (CSO) relating to manufacturing statistics are, (i) Annual Survey of Industries, summary result for the factory sector. This is published every year and presents summary results of 32 selected characteristics. Data at 2 and 3 digit level of disaggregation are given for all the states and for all India. The important characteristics for which estimates are available are number of factories, capital (fixed, working, invested), number of workers, employees, total persons, man days, wages, emoluments, outstanding loans, fuels and materials consumed, gross output, depreciation, net value added, net income, profit, rent paid and interest paid. (ii) Annual Survey of Industries, detailed results for factory sector. In this publication of ASI from 1993-94 onwards detailed tabulation is being undertaken on annual basis. These volumes provide detailed all India, state wise, as well as industry wise data at 4-digit level of industrial classification.

\textsuperscript{13} The CSO is following a new commodity classification system NIC 1998, which is based on the ISIC 1990 (which is also harmonized with International Harmonised Commodity description a coding system, HS 1996. Efforts have been made construct every 4 / 5 digit category of revised NIC in such a manner so that one or more subheadings of HS can be assigned as a whole, to only one such category of NIC, to the extent possible.
One of the major limitations of the Annual Survey of Industries is that it does not provide data on advertising expenditure, the extent of foreign collaboration, marketing expenditure intensity, etc which is essential to understand the marketing structure such as industrial concentration, scale efficiency etc. Further data pertaining to individual factories within industry is not available. To overcome the above deficiencies of the ASI data, PROWESS database, which provide the firm level data including market structure, can be used.

PROWESS

The CMIE provides firm level statistics through its various publications and mostly through the electronic database 'PROWESS'. In terms of number of variables, for which information is available, this is the most comprehensive of available database. The industrial classification followed is much disaggregated. The data are available from 1988-89 onwards.

The RBI, BSE and Department of Company Affairs (DCA) also provide data at firm level\textsuperscript{14}. The RBI provides data on finances of small, medium and large public limited companies, which is published in the RBI bulletin. Data was provided on a quinquennial basis until 1980-81 since then it is provided for three years. The basic data file of survey containing the company statistics is not being published, but it is possible to access on special request. But the limitation of the data is that it is essentially a sample data, thus the number of firms covered is comparatively less. Another major source of firm level data extensively used for research work is the 'Stock Exchange Official Directory published by BSE. Every issue contains data for the last 10 financial years. The DCA is another agency providing firm level data through its various publications. The DCA provides data of about 25000 public limited companies which are now available

in an electronic database ‘First source’ supplied by the CMIE. The major limitation of the BSE and DCA data is that the number of variables for which data provided is very few. The ICICI and IDBI also provide data at firm level\textsuperscript{15}. The present study used PROWESS database.

In addition to these sources Economic Survey, Monthly Abstract of Statistics, etc. also provides data on trade, industrial characteristics and other related variables on Indian economy\textsuperscript{16}.

### 3.2 Methodology

The present study examines the impact of trade reform on the export performance of India. The study to discern the influence of trade liberalisation is carried out at the aggregate level of export, industry level and at the firm level. Export performance is examined by using various growth rate and percentages. Average, and compound growth rates are used to examine the growth rate of exports. Determinants of exports at the aggregate levels are examined by using the Multiple regression, cointegration and Error correction methods. In order to examine the export performance of 15 industries as per the Annual Survey of Industries classification in India growth rate, export intensity, and import penetration ratio are mainly used. Multiple regression models are used to examine the impact of liberalisation at the industry level. The determinants and impact of trade liberalisation at the firm level is examined for seven industries by using the Tobit model. The models and the variables used for the analysis are given below.

Impact of trade liberalisation on India’s exports at aggregate level is examined using Error Correction Model. Vector Error Correction Models is used

\textsuperscript{15} The data available with ICICI and IDBI covers only those companies assisted by these organizations.

\textsuperscript{16} Data on trade and other variables on Indian economy are also available in electronic form in India stat.com.
for the analysis. The Vector Error Correction models use error term from
cointegration vectors. Johansen and Juselius Cointegration method is used in the
present study. The cointegration method requires the variables to be stationary.
The stationarity of the variable is examined using Augmented Dickey Fuller Test.

3.2.1. Augmented Dickey Fuller Test

The variables used for the analysis is tested for stationarity. From a
theoretical point of view, a time series is a particular realisation of a stochastic
process. If the underlying stochastic process that generates the series is assumed
to have finite parameters and to be invariant with respect to time, then the
process is said to be stationary. This simply means that the mean, variance and
auto covariances of the series are all constants. In this case, i.e., if the process is
stationary, the time series can be described by a simple algebraic model. If, on
the other hand, the characteristics of the stochastic process change over time i.e.,
non-stationary, it is not possible to model the process in terms of an equation.
Stationarity can be tested using Dickey Fuller test (DF), Augmented Dickey
Fuller test (ADF) or by Philip Peron test\textsuperscript{17}. The present study used Augmented
Dickey Fuller Test for testing the stationarity. The model used for the analysis is

\[
\Delta X_t = \alpha_0 + \beta X_{t-1}^{\delta} + \sum_{i=1}^{\delta} \theta_i \Delta X_{t-i} + \varepsilon_t
\]

Where \(\Delta\) is the difference operator, \(t\) is the time trend, \(\varepsilon\) is the stationary
random error, \(m\) is the maximum lag length. Null hypotheses is that \(\beta = 0\), exists
unit root. It will be rejected if \(\beta\) is negative and statistically significant.

\textsuperscript{17} Philips and Perron have developed a more comprehensive thory of uniot root . The test are similar
to ADF tests but they allow an automatic correction to Dickey Fuller procedure to allow for
autocorrelated residuals. The test often gives the same conclusion and suffers from the most
limitations of ADF tests.
3.2.2. Johansen and Juselius Cointegration Test

Cointegration test is used for testing the existence of a long run equilibrium relationship between variables. The concept of cointegration was introduced by Granger (1981) and Engle and Granger (1987), and is used as a statistical property to describe the long-run behaviour of economic time series. A variable is integrated if it requires differencing to make it stationary. If the (non-stationary) series is differenced d times to make it stationary, then the series is said to be I (d). If two series yt and xt both are I (1), then in general, any linear combination of them will also be I (1). A set of integrated time series is cointegrated, if some linear combinations of the series are stationary. Thus, given two variables yt and xt, if they are indeed I (1) processes, verified through some unit root tests, a simple method of testing whether they are cointegrated is to estimate the ‘cointegrating regression’ and then test whether the residual ut is I (0) or not. Such residual based procedures were the earliest cointegration test. In addition to the residual based testing, advanced methods like Engle and Granger and Johansen and Juselius methods are also used for estimation.

The present study used the Johansen and Juselius (JJ) (1990) cointegration estimator for cointegration analysis. This technique overcomes some of the shortcomings of the Engle-Granger (1987) cointegration method. The Johansen (1988) method, which was later, revised by Johansen and Juselius (1990) allows for testing more than one cointegrating vector in the data by calculating the Maximum likelihood estimate of these vectors. The existence of more than one cointegrating vector implies higher stability of the model. Johansen and Juselius test result gives two test statistics, Trace test and Maximum Eigene value test. Trace test is a joint test where the null is that then number of cointegrating vectors is less than or equal to r against an unspecified or general alternative that there are more than r. Max Test conducts separate test on each eigenvalue and its null hypotheses is that the number of cointegrating vector is r against an
alternative of r+1. The Max test is recommended as the better test among the two. In this model all the variables are treated as endogenous. The equation for estimation can be written in a Vector Auto Regressive (VAR) framework as follows.

\[ Y_t = \Pi i Y_{t-1} + e_t \]

When the series are I (I) the system can be formulated in an equilibrium Error Correction form as

\[ \Delta y_t = \Sigma \delta i \Delta y_{t-1} + \gamma y_{t-1} + e_t \quad i = 1,2,\ldots,p-1 \]

Where \( \gamma \) is the long run coefficient matrix. With the assumption that \( Y_t \) is I(1), \( \gamma \), can not be full rank and rank of \( (\gamma) = r < n \), there exists linear combinations of \( y_t \). The impact multiplier can be written as

\[ \gamma = \alpha \beta' \]

Where \( \alpha \) and \( \beta \) are (nxr) matrices of rank and \( r \) and \( \beta' y_t \) comprises \( \gamma \) cointegrating stationary relations. Then the equation can be written as

\[ \Delta y_t = \Sigma \delta_i \Delta y_{t-1} + \alpha (\beta' y_{t-1}) + e_t \quad i = 1,2,\ldots,p-1 \]

Johansen (1988) and Johansen and Juselius have derived the likelihood ratio test to determine the cointegrating rank (r) of \( \gamma \). The null hypotheses that at most \( r \) (ie, \( 0 \leq r \leq n \)) cointegrating vector is tested using the trace test with the statistics tested using the trace test with the statistics

\[ \lambda_{\text{trace}}(r) = -T \sum_{i=r+1}^{g} \ln(1 - \lambda_i) \]

The likelihood ratio test statistics for the null hypotheses of \( r \) cointegrating vectors against the alternative \( r+1 \) cointegrating vector is the maximum Eigen value.

\[ \lambda_{\text{max}}(r, r+1) = T \ln(1, \lambda_{r+1}) \]
Johansen and Juselius (1990) indicated that the Trace test may lack the power relative to Maximal Eigenvalue. Based on the power of a test maximum eigenvalue is preferred.

3.2.3. Vector Error Correction Models

In order to examine the long run impact of the trade policy, Error Correction model is used. The Error Correction model combines long run information with a short run adjustment mechanism. That is the Error Correction model contains the information, whether the past values of the variables affect the current values of the variables under consideration. The error correction term often denoted is nothing other than the residual from the level regression. The error correction model in the present study is used to examine the long run relationship between variables. The principle behind the model is that there often exists a long run equilibrium relationship between economic variables. In the short run there may be disequilibrium, with the error correction mechanism, a portion of the disequilibrium in one period is corrected in the next period. The Error Correction model is thus a means to reconcile short run and long run behaviour. Notable contributions in the area have been made by Saragan (1964) Davidson, Hendry, Serba and Yen (1978), Carrie (1981), Dawson (1981) and Engel and Granger (1987). An important theorem known as the Granger representation theorem, states that if two variables Y and X are cointegrated then the relationship can be expressed as Error Correction Mechanism. Different methods to estimate Error Correction Model also exist. Almost all model uses error terms from cointegrating vector for estimating Error Correction Model. The present study used Vector Error Correction Model (VECM) for the analysis.

Vector Error Correction Model (VECM) is essentially a Vector Autoregression Model (VAR). The VECM includes the error correction term from the cointegration equation. It allows all the variables in the system to
interact with itself and with each other, without having to impose a theoretical structure on the estimate. It also provides a method of analysing the impact of a given variable on itself and on all other variables. The impact of each variable can be assessed using variance decomposition and impulse response function. In the present study impulse function and variance decomposition are not considered. The vector Error Correction model used for the present analysis is

$$\Delta Y_t = \theta_0 + \sum_{i=1}^{k-1} \theta_i \Delta Y_{t-1} + \alpha \beta^\prime Y_{t-k} + \epsilon_t$$

Where $\Delta$ is the difference operator, $Y_t$ is vector of time series variables, $\theta_0$ is the intercept and matrix $\beta$ consists of $r$ cointegrating vector $\epsilon$ is the error term.

3.2.4. Model Adequacy Tests

In order to test whether the fitted model is correctly specified or adequate the following Model Adequacy tests are also used in the present analysis.

RESET-The RESET (Regression Specification Test) developed by Ramsey (1969), tests functional form misspecification. The null hypotheses of no functional form misspecification would be rejected if test statistics were too high.

General Heteroscedasticity Test (F-test)-The assumption of no heteroscedastic errors should also be checked using White's (1990) General heteroscedasticity (F-test). A small P value (associated with large F value) rejects the null of no heteroscedasticity in errors.

ARCH-Auto Regressive Conditional Heteroscedasticity (ARCH) is used for checking the serial correlation in errors.
The instability of the parameters in the model is examined through a joint (F) statistics, large value of which reveal parameter non-constancy and indicate a fragile model with some structural breaks.

3.2.5. Multiple Regression Models

The study used multiple regression models mainly for examining the determinants of exports in the pre and post reform period and for assessing the impact of the trade reform on the Indian manufacturing industries. The multiple regression models used for the present analysis is specified as follows

\[ Y_t = \alpha + \beta X_{its} + \epsilon_t \]

Where \( Y \) is the dependent variable selected for the analysis and \( X_{its} \) are the explanatory variables selected and \( \epsilon_t \) is the error term

3.2.6. Granger Causality Test

The direction of causality is tested by Granger Causality test. This test explains the direction of causation between the variables selected for the analysis. The intention behind Granger test is that suppose X Granger causes Y but Y does not Granger cause X, then past values of X should be able to help to predict future values of Y, but past values of Y should not be helpful in forecasting X. When we identify one variable as the dependent variable (Y) and another as explanatory variables, we make an implicit assumption that changes in the explanatory variable induces changes in the dependent variable. This is the notion of causality in which information about X is expected to affect the conditional distribution of the future values of Y. If X causes Y and Y causes X, then there is feed back effect, that is jointly determined and other wise it is determined unidirectionally.
The test statistics is explained as,

\[ F = \frac{(ESR - ESS)/q}{ESS/n - p - q} \]

where ESR is the Explained Sum of Residuals, ESS is Explained Sum of Squares, q degrees of freedom for numerator, n-p-q- degrees of freedom for denominator.

3.2.7 Tobit model

The factors that determine the export intensity of the firm is examined using the Tobit model. The Tobit model is used for the analysis as the export behavior of the firm involves two important decisions that are whether to export or not. In this case the dependent variable may take value as zero or the actual export value. In such a situation where values of dependent variable is not observed for some of the observation Tobit is the suitable model. The general form of Tobit model is that

\[ Y_t = \begin{cases} 
\alpha + \beta X_t + u_t & \text{if } Y_t > 0 \text{ or } u_t > -\alpha - \beta X_t \\
0 & \text{if } Y_t \leq 0 \text{ or } u_t \leq -\alpha - \beta X_t 
\end{cases} \]

The Basic assumption behind the model is that there exists an index function, \( I_t = \alpha + \beta X_t + u_t \). If \( I_t < 0 \) the value of the dependent variable is Zero and if \( I_t > 0 \), the value of dependent variable is It. Suppose that the \( u \) has the normal distribution with mean Zero and variance \( \sigma^2 \) then ‘Z’ standard normal random variable is defined as,

\[ Z = u/\sigma \]

denoting \( f(Z) \) the probability density of the standard normal variable \( Z \), and \( F(Z) \) its cumulative density, ie, \( P(Z<x) \). Then the joint robability density for those observation for which \( Yt \) is positive is given by
\[ P_1 = \prod_{i=1}^{I=m} 1/\sigma f[Y_i - \alpha - \beta X_i, \sigma] \]

where \( \Pi \) denotes the products and \( m \) the number of observation with positive \( y \) values. The probability function for observation with Zero \( y \) value is defined as

\[ P_2 = \prod_{j=1}^{J=m} p[u_j \leq -\alpha - \beta X_i] \]

The joint probability for the entire sample is given as \( L = P_1 P_2 \). As it is non linear in \( \alpha \) and \( \beta \) Ordinary Least Square procedure is not appropriate. The direct interpretation of the individual variable is not possible in Tobit model so the relationship with the variable is explained in the present analysis.

The model used for the present analysis is given below

\[ E x_{it} = X_{it} \beta + U_{it}, \text{ if } X_{it} + U_{it} > 0 \]

\[ = 0 \text{ if } X_{it} + U_{it} = 0 \]

where \( X_{it} \) is the factors that explains the export intensity of \( i^{th} \) firm in \( t^{th} \) period. Exit- is the export intensity of firms.

This model takes into account the probability as well as the intensity of exports. The Tobit model is used to examine the determinants of firm level exports and also to examine the impact of trade reform.

These are the methods used in the present analysis to satisfy various objectives. The description of the variables are given in respective chapters.
3.3 Chapter Scheme

The study is divided into nine chapters. The introductory chapter is followed by chapter on theoretical framework and review of literature. The data source and methodology is explained in the third chapter. Chapter four gives trade policy measures introduced in India. Trends in export performance of India is examined in chapter five. Analysis of the impact of trade liberalisation on aggregate exports is included in chapter six. Chapter seven examines the impact of trade liberalisation at industry level and chapter eight analysed the impact of trade liberalisation on the export behaviour of firms. Summary and conclusions are given in chapter nine.

3.4 Limitations

The analysis is based on the secondary data. So there may be the problems related with the time series data analysis. We have adjusted the problems of Multicollinearity, Autocorrelation and Heteroscedasticity to the possible extent so as to retain the significance of the model. Another limitation of the study is that due to non availability of data for some of the analyses, the period of analysis is not from 1980. As India adopted Harmonised Code system from 1987 the item wise analysis at aggregate level is examined since 1987. The firm level data are available since 1989 only so the analysis is done from that year. Trade policy variables like openness index and liberalisation dummy are used in the study by taking its limitations into consideration. The analysis is on exports, so that impact on imports is excluded. Among the exports, manufactured exports of goods are selected for the analysis so that trade in service is not taken into consideration for the present analysis.