Chapter II

ECONOMETRIC MODELS
Chapter-II
ECONOMETRIC MODELS

This chapter deals with the factors affecting supply of, and the demand for, the United States' imports from India. It makes an attempt to estimate the demand equation, the supply equation, and the market clearing equation. There are a number of factors to consider in an analysis of this kind. The principle variables, which must be considered in drawing up an econometric study are discussed first. Next econometric models of demand and supply are derived and analyzed.

A. Factors affecting Demand for the United States' Imports from India

Factors which affect demand for United States' imports from India are also several in number. The important variables are listed below.

a) United States' real disposable income
b) India's export prices
c) Relative price ratio = United States' domestic price
   India's export price
d) Prices of the Substitutes = India's export price
   World export price
e) Exchange rate
f) Two quarters' lag
g) Suez Canal
In constructing a model of the kind, it is necessary to consider each factor singly and also its effect in combination with the other variables. Such variables as United States' real disposable income, India's export prices, relative price ratio, and exchange rate all affect the quantity demanded by the United States. A detailed explanation of each of these factors is presented here to form a better understanding of the total subject matter.

(a) United States' Real Disposable Income

The United States' income creates the demand for its imports. As the United States' income increases, the demand curve shifts to the right. Among the four variables (United States' real disposable income, United States' real gross national product, United States' real net national product and United States' real total consumption), the United States' real disposable income is the best regressor.

(b) India's Export Prices

The demand curve depicts the relationship between price of the product and the quantity demanded. The
United States' demand for India's exports shows the relationship between India's export prices and the quantity of the United States' imports from India. If the United States' price elasticity of demand for India's exports is unitary, then the increase in India's export prices will not change India's foreign exchange earnings from exports to the United States with respect to the export prices. The combined price elasticities of demand should be approximately one.

\[(c) \frac{\text{U.S. Domestic Price}}{\text{India's Export Price}} = \text{relative price ratio}\]

If the United States' domestic prices increase faster than India's export prices, then the quantity demanded by the United States will increase.

\[(d) \frac{\text{India's Export Price}}{\text{World Export Price}} = \text{prices of the substitutes}\]

If the United States' income is increasing and the United States' imports are increasing over the time period, while India's export prices are increasing less than the world prices, then the United States' demand for India's exports should increase.

\[(e) \text{Exchange Rate}\]

The exchange rate has a direct impact on the prices of the imports. Rupee devaluation means lower
prices for the United States' imports from India. There should be a positive relationship between the exchange rate and the dollar value of imports by the United States from India. As the Rupee devalues against the dollar, the dollar earnings of the United States imports from India should increase.

(f) *Lagged Variable - Two Quarters' Lag*

There should be a quarters' lag for the time to transport the goods from India to the United States. There might be a quarter's lag between the changes in the United States' income and their reflection in the import-decision.

(g) *Dummy Variable: Suez Canal Closed or Open*

The closing of the Suez Canal has increased the transportation time from India to the United States.

(h) *United States' Foreign Exchange Reserves*

If the United States' balance of payment is in deficit, the United States may try to cut down on imports. As the foreign exchange reserve decreases, the imports may decrease.

(i) *Import Tariff*

Increased import tariff by the United States'
may increase the price paid by the United States' consumer. Increased price may have an impact on the United States' imports from India.

(j) Indian Immigrant Population

Another factor contributing to increasing United States' imports from India is the growing Indian immigrant population in the United States. As Indian immigrants, Indian-born American citizens, the Indian student population, and the population of Indian ethnic origin increase, India's exports to the United States' increase. These groups create a demand for Indian food products. They open business ventures such as Indian gift and grocery shops and now they are selling non-traditional items, such as engineering goods. Such changes in the immigration of Indian people have brought about changes in the demand for India's exports to the United States.

B. Factors Affecting Supply of India's Exports to the United States

The following are some principle factors affecting supply of India's exports to the United States:

a) India's Real National Income
b) Consumption - Population
c) India's Export Prices  
d) Relative Price ratio: \( \frac{\text{India's Export Price}}{\text{India's Domestic Price}} \)  
e) Exchange rate  
f) India's foreign exchange reserves

(a) India's Real National Income

India's production level should have an impact on the supply of the exports. India's real national income increases should parallel India's exports.

(b) Consumption - Population

As India's population increases and domestic consumption increases with growing industrialization, the supply of the primary products for the exports to the United States should reflect an increase.

(c) India's Export Prices

Export price and the value of exports should be positively related. An increased price will give suppliers from India an added incentive to place their goods on the export market to the United States.

(d) Relative Price Ratio = \( \frac{\text{India's Export Price}}{\text{India's Domestic Price}} \)

If India's export prices increase faster than the domestic prices, then the quantity supplied for exports should increase.
(e) Exchange Rate

As more rupees are available for the dollar, the supply of India's exports to the United States should increase.

(f) India's Foreign Exchange Reserves

As India's foreign exchange reserve decreases, India's exports to the United States should show an increase. This could be because of the efforts made by public and private sectors. As need for foreign exchange increases, efforts to increase exports should rise.

The above mentioned factors apriori affect supply of and demand for India's exports to the United States. In the following pages econometric models of demand and supply are derived and analyzed.

C. Demand and Supply Models

An econometric model for the United States' demand for the goods imported from India may now be derived for prediction purposes. The data are collected from International Financial Statistics and U.S. Imports. The equation derived by the least squares may be satisfactory for predicting the value of Y, the dependent variable, as the independent variables change. But the
least squares' equations are not satisfactory for
finding the coefficients of the independent variables
and their signs for forecasting, when there is multi-
collinearity among the independent variables.

In the demand model, the eigenvalues are 2.92,
2.62, .21, .17, .06 and .01. In the ordinary least
squares demand models, the signs of the predictor
variables are not correct in all cases due to the multi-
collinearity among the independent variables. These
problems could be alleviated by using the ridge
regression technique instead of ordinary least squares.

The following is a standard multiple linear
regression model:

\[ Y = B_0 + X B + \epsilon \]

X represents nxp matrix of the regressor variables of
rank p. Vector \( B = (B_1, \ldots, B_p) \) is unknown, and it
represents a vector of regression coefficients. \( \epsilon \) is
distributed normally with 0 mean and \( \sigma^2 \) in co-variance
matrix. The assumption is made that X is standardized,
which creates \( X'X \), a correlation matrix. If \( X'X \) is
illconditioned, that is when one or more eigenvalue is

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1/ Donald W. Marquardt and Ronald D. Snee, "Ridge
Regression in Practice", American Statistician,
29 (February 1975), 3-20.
near zero, then the ordinary least square estimator $\hat{\beta} = (X'X)^{-1}X'Y$ of $\beta$ could be less desirable than the ridge solution $\hat{\beta} = (X'X + \lambda I)^{-1}X'Y$ in terms of mean square error because of the multicollinearity problem.

The following is the demand equation derived by the least squares method.

$$
\log_e Y = 11.193 + (-.638) \log_e X_1 + (.393) \log_e X_2 \\
(5.50) \quad (-3.24) \\
+ (.017) \log_e X_3 + (-1.083) X_4 + (.306) \log_e X_5 \\
(2.16) \quad (-3.32) \quad (2.13)
$$

$$
+ (-1.058) \log_e X_6 \\
(-4.73)
$$

$Y =$ India's exports to the United States  
$X_1 =$ Exchange rate  
$X_2 =$ Price ratio = India's export price  
$X_3 =$ Suez Canal  
$X_4 =$ United States' total imports  
$X_5 =$ India's exports to the United States with one year lag  
$X_6 =$ United States' reserve

In the above equation, the total number of observations are twenty. The coefficient of determination $r^2$ is .99.

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The standard deviation is 1225. The Neumann - Hart statistic is 2.5665.

The least squares equation of demand with the t-values of the corresponding coefficients of the independent variables shows that with thirteen degrees of freedom, while disregarding the signs of the coefficients, the variables $X_4$ (exchange rate), $X_5$ (United States total imports), and $X_6$ (United States reserve) are significant at one per cent level. $X_3$ (Suez Canal) and $X_7$ (India's exports to the United States with a one-year lag) are significant at five per cent level; and $X_2$ (price ratio) is significant at ten per cent level.

In the following table, $K$, the ridge trace is selected in cases in which the prediction residual errors are the lowest. $K$ was selected by using the following formula:

$$K_d = \frac{P \sigma^2}{\sum_{i=1}^{P} \lambda_i a_i^2}$$

Ridge Regression Coefficients

$K = .0553$

Table II.1

<table>
<thead>
<tr>
<th>Variable</th>
<th>( B )</th>
<th>( \text{L.S.} )</th>
<th>( \text{VIF} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( X_1 ) Exchange rate</td>
<td>-.4280</td>
<td>135</td>
<td></td>
</tr>
<tr>
<td>( X_2 ) Price ratio</td>
<td>-.0759</td>
<td>115</td>
<td></td>
</tr>
<tr>
<td>( X_3 ) Suez Canal</td>
<td>.0200</td>
<td>3831</td>
<td></td>
</tr>
<tr>
<td>( X_4 ) United States' total imports</td>
<td>.4363</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>( X_5 ) India’s exports to the U.S. with a one-year lag</td>
<td>.5040</td>
<td>277</td>
<td></td>
</tr>
<tr>
<td>( X_6 ) United States' reserve</td>
<td>.0564</td>
<td>61</td>
<td></td>
</tr>
</tbody>
</table>

When \( X_4 \) increases by one standard deviation, \( Y \) increases by .4363 standard deviation in the table II.1, with thirteen degrees of freedom, the variable \( X_5 \) (India’s exports to the United States with a one-year lag) is significant at the one per cent level; the variable \( X_4 \) (the United States’ total imports) is significant at the five per cent level. These two variables together lead \( R^2 \) to .95. In this tabulation, the signs of the coefficients of the predictor variables match with the previous theoretical knowledge. The economic impact of variable \( X_1, X_2, X_3, \) and \( X_6 \) is limited, since the coefficients of these variables are quite small.

The sign of the coefficient of variable \( X_1 \) (exchange rate) of the demand model is negative.
Figure 1
Demand

B PRIME

India's exports to U.S.
12 = United States total imports
13 = United States' Reexports
10 = Suez Canal
8 = Exchange Rate
9 = Price Ratio
The exchange rate has a direct effect on the price of the imports. Rupee devaluation means lower price for the United States' imports from India. If the demand were highly elastic, there would be a positive relationship between the exchange rate and the dollar value of imports into the United States from India. However, since it is not elastic, the coefficient of the exchange rate is negative. The sign of the coefficient of variable $X_2$ (price ratio) of demand model is negative. If the United States' domestic prices increase faster than India's export prices, then the quantity demanded by the United States will increase.

With respect to variable $X_3$ (Suez Canal), the sign of the coefficient is positive in the demand model. The closing of the Suez canal has increased the transportation time from India to the United States. The opening of the Suez canal has a positive effect on the United States' demand for India's exports.

The sign of the coefficient of variable $X_4$ (United States' total imports) of the demand model is positive. The effect of the increased United States' total imports on the United States' imports from India is positive; however, India's export market in the United States is very competitive. The United States'
total import has increased at a faster rate than India's exports to the United States.

The sign of the coefficient of variable $X_2$ (India's exports to the United States with a one-year lag) of demand model is positive. The relationship between India's exports to the United States with a one-year lag is a positive one. This could mean that inventories of India's exports are not accumulated in the United States. If the previous year's consumption of India's exports to Americans had yielded satisfactory results, then there would be further demand the following year. The variable, India's exports to the United States with a one-year lag is an important and significant one in the demand model.


Branson provides the following import demand function of the United States.

$$\frac{m_i}{y_t} = B_0 + B_1 Y_t + B_2 X_t + B_3 C_t$$

$m = United States imports of goods i$

$y = United States' income$

$y_t = United States' real income$

$x = Capacity Utilisation$

$c = Proportion of income spent on good i$

$p = Domestic price of good i relative to its foreign price$

Branson's results indicate that the United States' imports were price elastic. The ratios of imports to gross national product were sensitive to the capacity utilization of the United States.
The coefficient of variable $X_6$ (the United States' reserve) of the demand model has a positive sign. If the United States' balance of payment is in deficit, the United States' reserves goes down, and the United States may try to cut down imports. Therefore, as the United States' reserve increases, India's exports to the United States also increases.

Besides the six variables that are mentioned in the multiple regression demand model, there are other variables related to India's exports to the United States that should be mentioned and explained. For example, such factors as India's exports and the United States' income must be considered. The relation between India's total exports and India's exports to the United States was a positive one during 1948-71. The following equation points out this fact:

$$\log_e Y = \log_e 2.508 + .343 \log_e X$$

$$Y = e^{2.508} x^{.343} = 12.28 x^{.343}$$

$Y$ = India's exports to the United States
$X$ = India's total exports

The $t$-values are in parentheses. The coefficient of determination $R^2$ is .49, which is relatively low, indicates that there are other factors to be included in explaining the behaviour of $Y$ variable in addition to
India's exports. The estimated standard deviation of \( Y \) is .1359. Thus, as India's total exports to the world increased, the value of exports to the United States from India also increased.

India's total exports to the world have also increased. Exports growth of India was especially brisk from 1972 onward. The growth rate of India's exports to the world in recent years have been as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972-73</td>
<td>22.5</td>
</tr>
<tr>
<td>1973-74</td>
<td>20.0</td>
</tr>
<tr>
<td>1974-75</td>
<td>31.9</td>
</tr>
</tbody>
</table>

It is obvious that increased Indian exports on a world basis also reflects an impetus for individual increase of Indian exports to the United States.

Although there are many variables affecting the demand of the United States' imports from India, the United States' real disposable income is found to be the major factor.

The United States' real disposable income is the best regressor among the United States' income
variables such as the United States' real disposable income, the United States' real total consumption, the United States' real national income, and the United States' real gross national product (table II.2). As seen from the following table, the United States' real disposable income is the best predictor of the value of the United States' imports from India annually.

Table II.2

<table>
<thead>
<tr>
<th>United States' Real Income</th>
<th>t</th>
<th>R²</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Disposable income</td>
<td>4.23</td>
<td>0.86</td>
<td>0.9995</td>
</tr>
<tr>
<td>2. Total Consumption</td>
<td>4.23</td>
<td>0.85</td>
<td>0.9995</td>
</tr>
<tr>
<td>3. National income</td>
<td>4.05</td>
<td>0.85</td>
<td>0.9995</td>
</tr>
<tr>
<td>4. Gross National Product</td>
<td>2.39</td>
<td>0.76</td>
<td>0.9995</td>
</tr>
</tbody>
</table>

The association between the United States' real disposable income and its impact can be traced from the following table II.3.

The ensuing equation estimates the effect of the United States' real disposable income on India's exports to the United States during the period 1952-71.

\[
\log_e Y = \log_e (-4.960 + 1.996 \log_e X) \\
(4.23) \quad (10.40) \\
Y = e^{-4.960} \times 1.996 = 7.01 \times 1.996
\]

Y = India's exports to the United States
X = The United States' real disposable income.
### Table II.3

<table>
<thead>
<tr>
<th>Year</th>
<th>U.S. Imports from India (in million $)</th>
<th>U.S. Real Disposable Income (in billion $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1953</td>
<td>228</td>
<td>312</td>
</tr>
<tr>
<td>1954</td>
<td>203</td>
<td>315</td>
</tr>
<tr>
<td>1955</td>
<td>224</td>
<td>343</td>
</tr>
<tr>
<td>1956</td>
<td>205</td>
<td>357</td>
</tr>
<tr>
<td>1957</td>
<td>204</td>
<td>362</td>
</tr>
<tr>
<td>1958</td>
<td>185</td>
<td>360</td>
</tr>
<tr>
<td>1959</td>
<td>209</td>
<td>366</td>
</tr>
<tr>
<td>1960</td>
<td>230</td>
<td>395</td>
</tr>
<tr>
<td>1961</td>
<td>255</td>
<td>407</td>
</tr>
<tr>
<td>1962</td>
<td>254</td>
<td>425</td>
</tr>
<tr>
<td>1963</td>
<td>294</td>
<td>439</td>
</tr>
<tr>
<td>1964</td>
<td>310</td>
<td>465</td>
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<tr>
<td>1965</td>
<td>345</td>
<td>501</td>
</tr>
<tr>
<td>1966</td>
<td>324</td>
<td>524</td>
</tr>
<tr>
<td>1967</td>
<td>298</td>
<td>546</td>
</tr>
<tr>
<td>1968</td>
<td>312</td>
<td>567</td>
</tr>
<tr>
<td>1969</td>
<td>344</td>
<td>575</td>
</tr>
<tr>
<td>1970</td>
<td>298</td>
<td>589</td>
</tr>
<tr>
<td>1971</td>
<td>329</td>
<td>615</td>
</tr>
<tr>
<td>1972</td>
<td>427</td>
<td>636</td>
</tr>
</tbody>
</table>

Sources: (1) *Monthly Foreign Trade Statistics, India.*
(2) *U.S. Statistical Abstract.*
U.S. IMPORT FUNCTION
\[ Y = ( -4.960 ) + ( 1.996 ) X \]

Figure - 2
INDIA'S EXPORTS TO THE U.S. ($)

UNITED STATES' DISPOSABLE INCOME (IN BILLION $)
The coefficient of determination $R^2$ is .86. The number of degrees of freedom is 18. The estimated deviation of $Y$ is .1933. This equation shows the relationship between the United States' real disposable income and the value of the United States' imports from India. The equation also represents the United States' import function from India; the income elasticity being 1.966.

As the United States' real disposable income increased, the value of the United States' imports from India also increased during 1952-71. This indicates that the value of the United States' imports from India will decrease when the United States' real disposable income decreases. A one-billion-dollar increase in the United States' yearly real disposable income will increase about two million rupees' worth of the United States' annual imports from India. This is the United States' marginal propensity to import from India.

The highly income elastic demand which the present study reveals may be explained in terms of

\[ \text{M. Datta, Op. cit.} \]

The results of the present research parallels other research findings on India's exports. For instance Datta had also found that demand for India's exports was income elastic for the sterling and the dollar areas.
Figure - 4

India's Exports to the United States
the considerable economic growth witnessed in the United States during 1952-71. The income elasticity moves the demand curve during most of the years to the right. Thus, income effect is creating an upward movement on a long run demand curve. On the average, the United States' economic growth rate is three percent. The United States' real gross national product grew at 3.4 per cent a year between 1890 and 1968.

The relative price ratio between India's export price and the world export price can be considered to be another factor affecting the demand for India's exports to the United States. The equation showing the effect of the relative export prices between India and the world is as follows:

\[ \log_{10} Y = 9.190 - 0.823 \log_{10} X \]

\[ (3.24) \quad (3.23) \]

\[ Y = e^{9.190} \cdot 803 \cdot 803 \]

\[ X = 9798.65 \cdot 803 \]

\[ Y = \text{India's exports to the United States} \]

\[ X = \text{Relative price ratio} = \frac{\text{India's export price}}{\text{World export price}} \]

Parentheses contain the t-values. The degrees of freedom are 18. The estimated standard deviation of \( Y \) is 1876, \( R^2 \) is .37. The low \( R^2 \) of the equation indicates that the role of price ratio is insignificant.

\[ 6/ \quad \text{Committee on Economic Development, Economic Growth in the United States, 1969, p. 27.} \]
Datta's study also found the price-ratio as insignificant in the import equations in the international trade research. In analyzing combined impact of independent variables on the dependent variable, with respect to overall aggregate estimates, the effect of price ratio is normally subsumed by income effect. The above mentioned equation shows that, as India's export prices increased compared to the world export prices, India's exports to the world export prices, India's exports to the United States decreased. If India's prices could compete with those of the world, India could increase its total exports to the United States, since during the United States' economic expansion, demand for India's exports increases. If India's price is not lower than the prices of the competing countries, India should provide enough subsidy for those particular goods.

The factors affecting supply of India's exports to the United States during 1952-71 may now be examined. The following model is the supply equation derived by the ordinary least squares method,

\[ Y = -54.38 + 25.93 X_1 + 256.07 X_2 \\
- 2.04 (-2.95) \\
+ 2.82 X_3 + 12.34 X_4 + 115.27 X_5 + 197.56 X_6 \\
(5.93) (2.34) (3.97) (3.11) \\
\]

\[ Y = \text{India's exports to the United States (1952-71)} \]
\[ X_1 = \text{India's gross capital investment} \]
\[ X_2 = \text{Export incentives} \]
\[ X_3 = \text{Relative price ratio} = \frac{\text{India's export price}}{\text{India's wholesale price}} \]
\[ X_4 = \text{India's population} \]
\[ X_5 = \text{Government Consumption} \]
\[ X_6 = \text{Exchange rate} \]

In the above equation, the t-values are in the parentheses. The total number of observations is twenty. The coefficient of determination \( R^2 \) is .98. The adjusted \( R^2 \) is .97. The Durbin-Watson statistic adjusted for zero gaps is 2.5534.

The least squares equation of supply with the t-values of the corresponding coefficient of the independent variables shows that with thirteen degrees of freedom, while disregarding the signs of the coefficients, the variable \( X_5 \) (Government consumption) and \( X_6 \) (exchange rate) are significant at the one per cent level. The variable \( X_7 \) (India's Gross Capital Investment), and the variable \( X_4 \) (India's population) are significant at the five per cent level.

The signs of the predictor variables are not correct in all cases in the afore-mentioned equation, and in addition, there is an occurrence of multi-
collinearity among the independent variables. In the supply model, the eigenvalues are 5.38, .45, .13, .02, .01, and .00. Since some eigenvalues are zero or close to zero, X'X is considered ill-conditioned. Moreover, variance inflation factors (VIF) also amplify the problem of multi-collinearity. VIF are the diagonal elements of the inverse of the simple correlation matrix. These problems are lessened by using the ridge regression technique.

Table II.4

<p>| Ridge Regression Coefficients | ( \lambda = .107 ) |</p>
<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>B</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>( X_1 ) India's gross capital investment</td>
<td>.00</td>
<td>138</td>
</tr>
<tr>
<td>( X_2 ) Export incentives</td>
<td>.32</td>
<td>115</td>
</tr>
<tr>
<td>( X_3 ) Relative price ratio</td>
<td>.05</td>
<td>14277</td>
</tr>
<tr>
<td>( X_4 ) India's population</td>
<td>.41</td>
<td>537</td>
</tr>
<tr>
<td>( X_5 ) Government consumption</td>
<td>.20</td>
<td>262</td>
</tr>
<tr>
<td>( X_6 ) Exchange rate</td>
<td>.01</td>
<td>29</td>
</tr>
</tbody>
</table>

The degree of sensitivity of the variable to the data is reflected in the above table II.4. The sensitivity is also displayed in the "Ridge-trace". (Appendix, Table-P. 43, 54, 55). The impact of variable \( X_1 \) (India's gross
Figure 5
Supply

B PRIME

2.00

1.00

0

-1.00

K

9 = Export Incentives
10 = Relative Price Ratio
12 = Govt Consumption
8 = India’s Gross Capital Investment
11 = Exchange Rate
13 = India’s Population
capital investment) in predicting India's exports to the United States is nil. The sign of the coefficient of the variable $X_2$ (export incentives) of supply model is positive. As incentives given to the suppliers in India increased, the supply of India's exports to the United States increased. The sign of the coefficient of the variable $X_3$ (relative price ratio) of supply model is positive. If India's export prices increase faster than the domestic prices, then the quantity supplied for exports should increase. The slope of the supply curve is positive.

The two important variables are $X_4$ and $X_5$. With $K = .15$, the combined effect of the two variables explains 81% of the change in $Y$.

$$K = .15$$

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_4$ India's population</td>
<td>.42</td>
<td>2.05</td>
</tr>
<tr>
<td>$X_5$ Government consumption</td>
<td>.45</td>
<td>2.19</td>
</tr>
</tbody>
</table>

The effect of India's population on the supply of India's exports to the United States is positive; this fact can be seen in the sign of the coefficient of the variable $X_4$. Increased population tends to keep the
wage level lower in India than in other countries that have lower population. Increased population, consumption, and industrialization create a higher demand for agricultural and industrial production. India's population growth had a positive impact on India's exports to the United States since India's relatively skilled and cheaper labour can compete with the other exporters to the United States. Population is the proxy of the working force. It is also an important and significant variable in the supply model.

The classical theory of comparative advantage is congruent with this population theory of exports. The Ricardian theory and the Heckscher-Ohlin theorem further supports the findings of the present study. According to Ricardo, a country's exports to another country could be explained by the international difference in the production functions. One of the important factors in Ricardo's analysis is assumed to be the labor factor. In the case of India's exports to the United States, the labor factor in India's production functions should certainly be a help in exporting.

According to the Heckscher-Ohlin theorem, a

---


country's exports use the country's abundant factor intensively. Obviously, on India's part, that abundant factor should be considered the labor factor. As Williams points out the trade between two nations is determined by the plentifulness of the resource content in relation to the rest of the world.

Analyzing the research results of Bhardwaj and Leontief, India's exports may represent more capital input than labor input in relation to the country's labor and capital stock. However, the cost of labor input might be less than many other countries which may provide comparative advantage to India. This might happen in the situation when even just a small labor input is utilized. However, the lower cost of labor input just might give an edge to India in competing against many other exporting countries to the United States.

Suppose that the exports of two countries to the United States are equal. The country that has comparative cost advantage over the time period would

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be able to expand the exports to the United States faster than the other one. The country that had an increase in population might have lower wage increase pressure as compared to the other.

The effect of Indian governmental consumption is positive on the supply of India's exports to the United States because the sign of the coefficient of variable $X_5$ is positive. Governmental consumption increases India's gross national product. Increased production enlarges the supply for exports. The sign of the coefficient of variable $X_6$ (exchange rate) of supply model is positive. As more rupees are available for exchange with the dollar, the supply of India's exports to the United States should increase.

Between the supply and demand models, the latter is better one. The two important independent variables on the demand side are India's exports to the United States with a one-year lag and the United States' total imports. On the supply side, the two important independent variables are government consumption and India's population. These are annual models, whereas many other trade models are quarterly.

Another factor affecting the supply of India's exports to the United States during 1952-71 was India's
real national income. The equation showing the effect of India's real national income on the supply of India's exports to the United States during 1952-71 is as follows:

\[ \log_e Y = \log_e (-4.155) + 2.227 \log_e X \]

\[ Y = e^{-4.155} x 2.227 = 0.016 x 2.227 \]

\[ Y = \text{India's exports to the United States} \]
\[ X = \text{India's real national income} \]

In the parentheses are the t-values. The coefficient of determination \( R^2 \) is .74. The number of degrees of freedom is 18. The estimated standard deviation of \( Y \) is .2524. Thus, as India's real national income increased during 1952-71, India's exports to the United States also increased. India's increased real national income affected the export supply to the United States positively. The income elasticity of supply of India's exports to the United States was elastic. Moreover, India's exports grew at an increasing rate during 1952-71, as India's real national income increased during the same time period.

As mentioned before, income effect in the trade literature is larger than the price effect. This keeps the \( R^2 \) of the price factor lower than income effect.
However, economists have theoretically emphasized the price effect. That is why the present paper analyzed the price variable. The equation showing the effect of India's exports to the United States during 1948-71 is as follows:

\[ \log_e Y = \log_e 2.915 + .563 \log_e X + \log_e v \]

\[ n = e^{2.915 \times .563} = 18.45 \times .563 \]

\[ Y = \text{India's exports to the United States}, \]
\[ X = \text{India's export price}. \]

T-values are shown in the parentheses. The coefficient of determination \( r^2 \) is .43, which is relatively low. The number of degrees of freedom is 22. The estimated standard deviation of \( Y \) is .137. The above equation shows that India's export prices and the value of India's exports to the United States during 1948-71 were positively related. An increase of India's export price brought a larger supply to the United States from India. The price elasticity of supply was .6 and it was inelastic. Yet another factor affecting India's exports to the United States during 1952-71 was the price ratio between India's wholesale price and India's export price.

The equation showing the effect of the relative price ratio between India's export price and India's
Wholesale price on her export to the United States during 1952-71 is as follows:

\[
\log Y = \log (-6.609) + 3.058 \log x + \log V \\
(2.37) \quad (4.96)
\]

\[
Y = e^{-6.609} \times 3.058 = 1.35 \times 3.058
\]

\(Y = \text{India's exports to the United States}\)

\(X = \text{Price Ratio} = \frac{\text{India's Export Price}}{\text{India's wholesale Price}}\)

In the parentheses are the t-values. The coefficient of determination \(R^2\) is .56. The number of degrees of freedom is 18. The estimated standard deviation of \(Y\) is .3326. Thus, India's supply of exports to the United States increased as the relative prices increased during 1952-71.

Using the supply model with six independent variables the following values were derived of the dependent variable. (Table II,5)

D. The Market Clearing Equation

To arrive at the exactly identified equation, the number of exogenous variable excluded from the equation must at least be equal to the number of endogenous variable included on the right hand side of
### Table II.5

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**Table II.6**

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Table II.6 (Continued)

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<td>.33</td>
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<td>.36</td>
<td>.38</td>
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Table III.2

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<td>1.99</td>
<td>1.56</td>
<td>0.9112</td>
<td>0.89</td>
<td>0.66</td>
<td>0.34</td>
<td>0.31</td>
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<td>India's export price</td>
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<td></td>
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<tr>
<td>India's wholesale price</td>
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<td></td>
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<tr>
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<td>$R^2$</td>
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</table>
the equation. In the present problem, the endogenous variable is only the export price, since in theory, quantity demanded and supplied are both functions of the price. This required condition restricts the number of variables that can be utilized.

In order to find out the price elasticity of the supply and demand curves, and to see where the market clears the supply and demand, the following is done:

\[ D = f (Y, P) \]
\[ S = f' (Ex, P) \]

\[ Y = \text{United States' Real Disposable Income} \]
\[ P = \text{India's Export Price} \]
\[ Ex = \text{India's Foreign Exchange} \]

\[ D = S \]

The Demand Equation

\[ \log_{e} Y = \log_{e} 0.505 - 0.252 \log_{e} X_2 + 0.741 \log_{e} X_3 + \log_{e} X_4 \]

\[ (0.025) (1.684) (4.595) \]

\[ Y = \text{The United States' imports from India in $} \]
\[ X_2 = \text{India's Export Price} \]
\[ X_3 = \text{United States' Real Disposable Income}. \]

The t-values are in the brackets. The adjusted \( R^2 \) is .98. The coefficient of \( X_3 \) is significant at .01 level. The
Durbin-Watson statistic adjusted for zero gaps is 1.77. The price elasticity of demand is .25 and a negative. The price elasticity of demand is inelastic.

The devaluation of the rupee did not act as a cure of the many problems with which India's exports to the United States were faced. Often effects of devaluation were coincided with agricultural droughts that had increased prices. The June, 1966 devaluation could not have increased the Indian traditional exports to the United States because of the production problems.

As the United States' real disposable income increased, India's exports to the United States also increased during 1952-71.

The Supply Equation

$$\log_e Y = \log_e 0.298 - 0.627 \log_e X_1 + 1.59 \log_e X_2$$

(1.02) (2.57) (6.4)

$$+ \log_e V$$

$X_1 =$ India's foreign exchange

$X_2 =$ India's export prices

The t-values are in the parentheses. The coefficient of $X_1$ and $X_2$ are significant at .01 level. Adjusted $R^2$ is .95. The Durbin-Watson statistic adjusted for zero gap is 2.17. The standard error of the regression
Figure 6

INDIA'S EXPORTS TO THE UNITED STATES
is 0.1667. The price elasticity of supply for India's exports to the United States is 1.59 and is highly elastic and positive during 1952-71. As India's foreign exchange decreased, the supply of India's exports to the United States increased. This may be the result of the efforts created by public and private sectors. As needs for foreign exchange increased, efforts to increase exports should have obviously increased.

In the above mentioned demand and supply equations, the price elasticity of India's exports to the United States is -0.2 in demand and +1.59 in the supply side of the equation. This is in line with the findings with other studies. Murti and Sastry, and M. Datta have calculated the price elasticity of India's exports in relation to the world. Their results show that demand was price inelastic. It seems, rather than acting as a price maker in the United States market, India appears to be a "price taker."

While price elasticity of demand is inelastic, price elasticity of supply is elastic. As supply price

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increases, a more than proportionate supply of India's exports to the United States are being brought into the market. Although price increase cuts down the quantity demanded, price decrease does not lead to proportionate increase in quantity demanded.

**Exchange Rate**

During 1952-71, twenty years modal time, the exchange rate in the international monetary market was fixed exchange rate rather than the flexible exchange rate. In this model, the exchange rate is the official exchange rate between rupees and dollars. There are other exchange rates in the international monetary markets. But there are dangers in using unofficial market rates. The official market rate is used here because international payments are supposed to be made officially. On the whole, during 1952-71, India devalued rupee against the dollar.

The demand for India's exports to the United States in general is price inelastic at about -.2 elasticity. In addition, elasticity of demand in respect to exchange rate is inelastic between -.6 and -.42. Price elasticity of supply was inelastic +.7. As rupee was devalued against the dollar, the supply of India's exports to the United States increased.
INDIA'S EXPORTS TO THE UNITED STATES

EXCHANGE RATE $ = Rs.
Since suppliers were getting more rupees from the same quantity of exports, the suppliers offered more supply to the market. The supply curve had a positive slope. Elasticity of exchange rate with respect to India's exports to the United States, was inelastic \(+0.01\). But the slope of supply with respect to the exchange rate was positive.

Price increases did not help whereas price decreases did, but not proportionately. Thus price decrease does not increase revenue.

Price increases result in the United States buying from a country other than India. Price decrease leads to a resultant decrease in revenue. If price increases are mandatory then it is an advantage to have the least price rise compared to the other competitive countries in the particular product market.

Lately, the rupee is being revalued against the dollar. Often Indian exporters to the United States are reluctant to commit themselves until they are positive about the direction of the trend. Revaluation does not help India's exports to the United States from the supply side. Initial revaluation cuts down the slope of the supply curve and makes the supply elasticity of price and exchange rate more
inelastic. Demand for India'a exports in the situation of revaluation rupee against dollar depends in the relation with the other competitors' exchange rates also. The individual commodities that have price elastic demand will be hurt by a cut in the quantity demanded. Moreover, the higher rate of inflation in the United States, as compared to that in India, could have a positive impact on United States' total imports from India.

The present chapter thus constructed econometric models with a view to identify the factors that have been in fact affecting the supply of and demand for India's exports to the United States. In the next chapter the focus is on analyzing the structure of India's exports to the United States.