CHAPTER 5
EMPIRICAL RESULTS AND DISCUSSION

5.0. TRENDS IN DATA:

Before we estimate the proposed model, as a preliminary exercise, we analyse the trends in all the important variables used in the study over the period 1960-61 to 1991-92. This can help in understanding the historical development in these variables over time. The trend analysis uses growth rates, means, standard deviations and graphs. The variables included in this trend analysis are real national income, money supply, price level, volume and unit values of exports and imports, credit and world price level. Tables 5.1-5.2 contain respectively the decade-wise growth rates, means and standard deviations of these variables. In Appendix, we give the actual data used in this study.

Real National income:

During the period under study, 1961-92, the real national income (GNP at 1980-81 prices) rose at the compound rate of 3.8% per year. GNP had increased (more than trebled) from Rs 58,602 crores in 1960-61 to Rs 1,86,135 crores in 1991-92 (see Graph 5.1). The growth in real GNP was slower in 60s, barely equal to Population growth, but picked-up during 70s and 80s. During this period, wholesale prices have also risen steadily at around 7-8% P.a., the overall rate of inflation being 8%.
Money supply:

The growth in money supply (M1) was slower during the 60s, but accelerated subsequently. During 1961-80, rate of increase in money supply was almost equal to the sum total of increases in real income and prices, thus balancing the rate of money supply with money value of output. But, in the 80s, money supply has grown faster, triggering an imbalance between the two. One of the sources of this imbalance seems to be creation of disproportionate amount of domestic credit which has registered an alarming 16.3% p.a. during 80s. The money supply has increased slowly during 60s at 9.5%, while it has grown much faster in 70s (13%) and in 80s (15.1%) and the overall growth rate being 12.5% per annum for the entire period 1960-61 to 1991-92. In absolute terms, money supply had increased manifold from Rs 2,869 crores in 1961 to Rs 1,41,111 crores in 1991-92 (see Graph 5.2). There had been a rapid increase from 1989 onwards.

Table 5.1: Annual Compound Growth Rates (per cent)

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Real Income</td>
<td>2.9</td>
<td>3.4</td>
<td>4.9</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>Money Supply</td>
<td>9.5</td>
<td>13.0</td>
<td>15.1</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>Wholesale Price Index</td>
<td>7.4</td>
<td>8.8</td>
<td>6.6</td>
<td>8.1</td>
<td></td>
</tr>
<tr>
<td>Exports Volume</td>
<td>0.9</td>
<td>7.6</td>
<td>6.0</td>
<td>5.2</td>
<td></td>
</tr>
<tr>
<td>Imports Volume</td>
<td>-0.2</td>
<td>5.6</td>
<td>7.1</td>
<td>5.2</td>
<td></td>
</tr>
<tr>
<td>Unit Value of Exports</td>
<td>9.1</td>
<td>10.8</td>
<td>8.4</td>
<td>8.4</td>
<td></td>
</tr>
</tbody>
</table>
Inflation:

Rate of inflation is measured by the rate of change in wholesale price index (WPI) for all commodities. It has registered 8.1% per annum during 1960-61 to 1991-92. There were, however, erratic year-to-year fluctuations in WPI. From 1960-61 to 1970-71, WPI rose by 7.4%. During 70s inflation was at 8.88% which fall to 6.6% during 80s (see Graph 5.3), Thus, the rate of inflation was consistently higher than the growth of real national income and lower than the rate of increase in money supply throughout the sample period.

Imports and Exports:

During 1961-80, imports, in volume terms, have grown slower than exports. But 80s have witnessed a reversal of this trend with widening trade gap, thus heralding a balance of trade and payments crisis which assumed unmanageable proportions soon after. Infact, the malice seem to have set-in during late 70s itself as trade balance figures indicate. The decade-wise rate of growth of exports shows that during 60s it was very low and had picked-up (7.6%) in 70s and decelerated to 6% in 80s. The overall growth rate of exports in volume terms was 5.3%. Similarly, imports were growing at 5.6% in 70s and 7.1% in 80s, the overall growth rate being 5.21% per annum, (see Graph 5.4 and 5.5).
Unit value of Imports and Exports:

The sizeable deceleration in import prices, from 15.2% in 70s to 3.8% in 80s, must have provided some breathing time for differing the imminent BOP crisis. It may be noted that import prices were volatile after 1973 oil crisis, more so during 80s. Export prices were rising at a rate of 9.1% during 60's, 10.8% during 70s and 8.4% during 80s and the overall growth rate being 8.4% per annum for the entire period (see Graph 5.6).

Table 5.2: Period-wise Mean and Standard Deviations

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Income (Rs cr)</td>
<td>66790</td>
<td>92776</td>
<td>138390</td>
<td>99319</td>
</tr>
<tr>
<td></td>
<td>(6232)</td>
<td>(10151)</td>
<td>(20867)</td>
<td>(32943)</td>
</tr>
<tr>
<td>Money Supply (Rs cr)</td>
<td>4405</td>
<td>13713</td>
<td>138390</td>
<td>21012</td>
</tr>
<tr>
<td></td>
<td>(1120)</td>
<td>(5036)</td>
<td>(20867)</td>
<td>(20817)</td>
</tr>
<tr>
<td>Wholesale Prices</td>
<td>25.95</td>
<td>55.98</td>
<td>124.88</td>
<td>68.9</td>
</tr>
<tr>
<td></td>
<td>(5.73)</td>
<td>(14.12)</td>
<td>(24.4)</td>
<td>(45.1)</td>
</tr>
<tr>
<td>Exports (Rs cr)</td>
<td>946.8</td>
<td>3770</td>
<td>13177</td>
<td>5965</td>
</tr>
<tr>
<td></td>
<td>(293.6)</td>
<td>(1829)</td>
<td>(6460)</td>
<td>(6504)</td>
</tr>
<tr>
<td>Imports (Rs cr)</td>
<td>1472.5</td>
<td>4512</td>
<td>19906</td>
<td>8630</td>
</tr>
<tr>
<td></td>
<td>(355.7)</td>
<td>(2468)</td>
<td>(7188)</td>
<td>(9237)</td>
</tr>
<tr>
<td>Unit value of Exports</td>
<td>33.8</td>
<td>70.0</td>
<td>154.7</td>
<td>86.2</td>
</tr>
<tr>
<td></td>
<td>(12.9)</td>
<td>(20.8)</td>
<td>(37.5)</td>
<td>(57.2)</td>
</tr>
<tr>
<td>Unit value of Imports</td>
<td>25.4</td>
<td>63.4</td>
<td>117.8</td>
<td>68.8</td>
</tr>
<tr>
<td></td>
<td>(7.2)</td>
<td>(26.2)</td>
<td>(17.3)</td>
<td>(42.5)</td>
</tr>
<tr>
<td>World Prices</td>
<td>17.5</td>
<td>36.8</td>
<td>107.5</td>
<td>53.9</td>
</tr>
<tr>
<td></td>
<td>(1.7)</td>
<td>(12.5)</td>
<td>(32.6)</td>
<td>(43.9)</td>
</tr>
</tbody>
</table>

* Figures in parantheses are the standard deviations.

Table 5.2 gives the period-wise mean and standard deviations for all the important variables. It can be seen from the table that for few variables like exports and imports standard deviations are higher than that of their respective mean values for the period 1961-1990. This shows that there are wide fluctuations in the data series. The mean value of real national
income is Rs 99,319 crores for the entire period 1961-90. Similarly money supply and inflation had an average values of Rs 21,012 crores and 68.94 respectively during the same period. Exports registered an increase in 1981-90 period with a mean value of Rs 13,177 and for the entire period it stood at Rs 5,965 crores. Imports too were on increasing side with an average value of Rs 8,630 crores. The world price index had an average value of 53.95 and the unit value of exports and imports averaged at 86.17 and 68.85 respectively.

5.1. Direction of Foreign Trade:

The direction of India's foreign trade indicates that there has been an increase in the importance of developing countries both as export destinations and as sources of imports. A major shift of trade between India and the OECD countries can also be noticed (Table 5.2).

Table 5.3: Direction of Trade (per cent)

<table>
<thead>
<tr>
<th>COUNTRIES</th>
<th>1960-61</th>
<th>1980-81</th>
<th>1989-90</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exports</td>
<td>Imports</td>
<td>Exports</td>
</tr>
<tr>
<td>1. OECD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) USA</td>
<td>16.0</td>
<td>29.2</td>
<td>11.1</td>
</tr>
<tr>
<td>b) Japan</td>
<td>5.5</td>
<td>5.4</td>
<td>8.9</td>
</tr>
<tr>
<td>c) UK</td>
<td>26.8</td>
<td>19.3</td>
<td>5.9</td>
</tr>
<tr>
<td>d) France</td>
<td>1.4</td>
<td>1.9</td>
<td>2.2</td>
</tr>
<tr>
<td>e) FRG</td>
<td>3.1</td>
<td>10.9</td>
<td>5.7</td>
</tr>
<tr>
<td>2. OPEC</td>
<td>4.1</td>
<td>4.6</td>
<td>11.1</td>
</tr>
</tbody>
</table>

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There have been changes in the commodity composition of exports and imports over time. Raw materials, intermediate manufactures and capital goods have continued to dominate our import basket. The share of food imports had declined compared to the 60s and 70s. Imports of petroleum products had increased sharply during eighties. Most of the imports being essential in nature, they tend to be price inelastic. On the exports front, the share of manufactures and engineering goods had increased sharply during eighties.

5.2. ESTIMATION OF CGE TRADE MODEL:

Data Transformations:

In the earlier section, we discussed the trends in some important variables that we use in empirical analysis. Annual time series data are collected on all the required variables—money supply (narrow money, M), wholesale price index of all commodities (price level, P), value of exports, value of imports, unit value of exports, net foreign assets (R) which are all endogeneous; and real national income (GNP at factor cost, Y), weighted average of real national incomes of all trading partners.

<table>
<thead>
<tr>
<th>Region</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
<th>E4</th>
<th>E5</th>
<th>E6</th>
<th>E7</th>
<th>E8</th>
</tr>
</thead>
<tbody>
<tr>
<td>USSR</td>
<td>4.5</td>
<td>1.4</td>
<td>18.3</td>
<td>8.1</td>
<td>16.1</td>
<td>5.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E4</td>
<td>14.8</td>
<td>11.8</td>
<td>19.2</td>
<td>15.7</td>
<td>15.4</td>
<td>17.0</td>
<td></td>
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</tr>
</tbody>
</table>

Source: Debroy (1992)
nominal exchange rate (E), amount of import tariff collected, amount of export subsidy incurred, unit value of imports (PMs), price level in trading partner countries (world price level, PW), reserve money (D+R, D being domestic credit) and essential imports (foodgrains plus petroleum products, IF), which are all exogeneous in nature. Two additional dummy variables were generated to reflect change in exchange rate regime (from fixed to floating exchange, DUMEXR) and inflation rate (high/low, DUMINF).

From this basic data set, variables which are needed for the analysis are generated in a consistent fashion (both in levels and units of measurement). For example, unit values of exports (PXs) and imports (indices) are treated as price indices of exports and imports respectively. They are used as deflators to compute volume of exports (X) and imports (I) from value of exports and imports. Likewise, the unit rates of tariffs (t) and subsidies (s) are obtained by dividing aggregate amounts of tariffs and subsidies with volume of exports and imports respectively. The domestic credit (D) variable is worked out as reserve money minus net foreign assets (R). Trade balance (TB) is computed as the difference between values of exports and imports. Net foreign assets (R) is treated as balance of payments variable.

For the estimation of the four structural equations
representing demand for real cash balances \((M/P)\), export demand \((X)\), unit value of exports \((PX_S)\) and import demand \((I)\), the appropriate price variables are generated. These include rate of inflation \((r - (P-P_{-1})/P_{-1})\), relative price of exports \((PX_S/PW)\), subsidy adjusted domestic price level \((P/(E+s))\) which measures the relative profitability of exports, import tariff adjusted price of imports \((PM_S(E+t)/P)\) to measure the real cost of imports and export linked foreign exchange resource available for imports \((KI_S+PX_SX)/PM_S\).

The important variable, viz., excess flow demand for real cash balances \((EM)\) is computed from historical data itself by assuming instantaneous adjustment of actual real balances to desired level (i.e., \(v=1\)). As a matter of fact, EM should be computed using the estimated money demand function. This requires a sequential, rather than simultaneous, procedure of estimation which would make EM susceptible to errors/inaccuracies in the estimation of money demand function. These errors can also percolate to other equations through EM. This problem is avoided by computing EM directly and independent of money demand function. In OLS estimation, EM thus is purely exogenous variable. However, in 2SLS, an instrumental variable is computed for EM as well along with other current endogeneous explanatory variables.

Annual time series data are used for estimating each equation in the system both by OLS and 2SLS methods. The model
is estimated using both linear and semi-log forms due to the
presence of r or EM (which take negative values) and for three
overlapping time periods. Data on import tariffs and export
subsidies are available only from 1971 onwards. Two equations
involving these variables viz., unit value of exports and import
demand could be estimated for the period 1971-91 only. The two
other equations, demand for real cash balances and export demand
were estimated using longer time series viz., 1961-91. Although
data are available for 1992, we could not use it for model
estimation because of its outlier nature (some variables are
quite away from previous series).

Choice of the "best" model:

In regression analysis, choice of appropriate functional
form, method of estimation and the length of time series, which
together determine the numerical values of parameters, are the
three most important tasks for the researcher. Even if we know
the list of endogenous and exogenous variables from the theory,
the "true" functional form is rarely known and to be decided by
the data and the analyst. Linear or log-linear functional forms
are the popular choices, because linear regression techniques can
be used and the parameters can be interpreted easily. Between
these two functional forms, log-linear functional form is more
often preferred because the regression coefficients can be
directly interpreted as elasticities with which the economists
are generally familiar.
For over-identified system of equations like the present model, 2SLS is recommended because OLS estimates suffer from "simultaneous equation bias". Thus, a priorily the choice of estimates is narrowed to log-linear model using 2SLS method. But, it must be added that the data may not conform to this a priori choice in the sense that there can be conflict between theoretical desirability and statistical goodness of fit. There is often need for trade-off between the two- theoretically consistent model may not be able to describe the given data well. Therefore, one needs to try and experiment with alternative naive methods as well. Keeping this in mind, OLS estimates are obtained for linear as well as log-linear (semi-log) model and 2SLS estimates for linear model only and are given in Appendix. Since both OLS and 2SLS methods use single equation approach, within each equation, the decision to retain a particular explanatory variable is based on appropriate sign for the regression coefficient and significant t-ratio. A few variables may be retained in the model even if either of the above criteria is not fulfilled, as departures from expected behaviour. OLS estimates are discussed for log-linear model. The estimated OLS equations are reproduced here from Appendix:

(a) Log-linear OLS Model
Sample period: 1962-91

\[ \ln (M/P) = -2.4931^* + 0.3903^* \ln Y - 0.8919^* \pi - 0.1539\pi \]
\[
\begin{align*}
\text{(A)} & \quad -0.2790^{***} \pi_2^+ + 0.6623 \times \text{ln } (M/P)_{-1} \\
& \quad (-1.74) \quad (4.75)
\end{align*}
\]

\[ R^2 = 0.98, \quad DW = 1.99, \quad F = 215.6, \quad \text{Dh statistic} = 0.0424 \]

\[
\begin{align*}
\text{In } X^d &= 1.4531^{*} - 0.5495^* \text{ln } (P/E+s) + 0.0230^* \text{ln } YW + \\
& \quad (3.93) \quad (-4.46) \quad (3.58)
\end{align*}
\]

\[ R^2 = 0.95, \quad DW = 1.40, \quad F = 138, \quad \text{Dh statistic} = 0.0424 \]

Sample period: 1971-91

\[
\begin{align*}
\text{In } P/x &= 1.4281^* + 0.0330 \text{ln } (P/(E+s)) + 0.7378^* \text{ln } PW \\
& \quad (6.94) \quad (0.36) \quad (27.50)
\end{align*}
\]

\[ R^2 = 0.99, \quad DW = 1.80, \quad F = 346.5 \]

\[
\begin{align*}
\text{In } I &= -3.4873^{***} - 0.1796^* \text{ln } (P/(E+t)/P) + 0.3492 \text{ln } Y \\
& \quad (-1.61) \quad (-4.27) \quad (1.50)
\end{align*}
\]

\[ R^2 = 0.99, \quad DW = 2.25, \quad F = 198, \quad \text{Dh statistic} = -.61 \]

\[
\begin{align*}
\text{In } X^s &= -4.6819^* + 0.5557^{**} \text{ln } Y + 0.5783^* \text{ln } X \\
& \quad (-2.10) \quad (2.18) \quad (3.00)
\end{align*}
\]

\[ R^2 = 0.93, \quad DW = 2.11, \quad F = 120, \quad \text{Dh statistic} = -.54 \]
Without EM

\[
\text{\text{In PX}}\text{\text{\textasciitilde}} = -7.8173* * * + 0.0667 \text{\text{In}} (P/(E+s)) + 0.3543 * * \text{\text{In PW}} \\
\text{\text{(\text{-1.66}}) (\text{0.48))} + 0.9199 * * \text{\text{In Y}} + 0.2154 * \text{DUMEXR} \\
\text{\text{\text{(2.05))} (\text{4.13))}} + 0.9199 * * \text{\text{In Y}} + 0.2154 * \text{DUMEXR} \\
R^2 = 0.99, \text{ DW} = 1.21, \text{ F} = 346.5
\]

\[
\text{\text{In I}} = -1.4814 - 0.2903 * \text{\text{In}} (PM\text{\text{(E+\text{t})/P}) + 0.1195 \text{In Y}} \\
\text{\text{\text{\text{(-0.36)}}} \text{\text{\text{(-4.01))}}} + 0.6695 * \text{\text{ln ((XPX-s-KI-s)/PM)}} + 0.0442 * * * \text{\text{ln (R/PM)}} \\
\text{\text{\text{\text{\text{(4.54)}}}) \text{\text{\text{(1.72))}}} + 0.4291 * \text{\text{In I}} - 1 + 0.1609 \text{\text{In IF}} \\
\text{\text{\text{\text{\text{(3.88)}}}) \text{\text{\text{\text{\text{(3.57))}}}}}} + 0.4291 * \text{\text{In I}} - 1 + 0.1609 \text{\text{In IF}} \\
R^2 = 0.99, \text{ DW} = 1.80, \text{ F} = 98, \text{ Dh statistic} = .5314
\]

* indicates 1% level of significance
** indicates 5% level of significance
*** indicates 10% level of significance

Money Demand Function:

A perusal at the estimated equations shows that the overall goodness of fit measured by $R^2$ is satisfactory for all the four equations. The demand for real cash balances (Eq. A) is well explained by real income, current rate of inflation and rate of inflation lagged upto two years. Lagged dependent variable has

\[\text{This is in contrast to the four-years lag observed in Sunderarajan (1986). We also tried the four-year lags, but lags of 3 and 4 years are not consistent in sign and statistically insignificant. This implies that inflationary expectations are of shorter memory now in determining the demand for real cash balances in India.}\]
the expected sign, with largest t-ratio in that equation and statistically significant coefficient. The explanatory variables have significant coefficients with expected signs. The coefficients of the lagged rate of inflation decline in magnitude (at least initially), and become statistically insignificant as we go back into the past. The distributed-lag structure for rate of inflation implies a fairly large and negative coefficient for expected rate of inflation.

The coefficients of real income (0.39) and lagged dependent variable (0.66) are statistically significant and quite close to the values obtained by Sunderarajan (0.32, 0.72) for the period 1952-77. This shows that the money demand function has been quite stable over time in the Indian context. Numerically, a 10% increase in output/real income leads to a 3.9% increase in demand for real cash balances indicating a strong link between level of economic activity and monetary base.

The speed of adjustment of actual real cash balances to the desired level is moderate-to-slow as seen from the coefficient shorter memory now in determining the demand for real cash balances in India.

2However, there is no consensus about the stability of money demand function in the literature.
for the lagged dependent variable \((v= 1-.6623 = .3377)\). The speed of adjustment seems to have picked-up since Sunderarajan's study. The coefficient of current inflation rate is \((- .8919)\). The large value for the coefficient of current inflation would mean a large value for \(\delta \pi / \delta \Delta \ln M\) viz. \(1/(1-.8919) = 9.25\). It implies that following an increase in rate of monetary expansion, the rate of inflation will tend to over-shoot initially and will adjust downward subsequently. This will have implication for the policy analysis to be undertaken in the next chapter.

Unit value of Exports:

The monetary disequilibrium variable is expected to influence trade flows both directly and indirectly through its effects on relative prices. The market for exportables is assumed to be in equilibrium and is described by a reduced form equation for unit value of exports and the structural equation for export demand.

The crucial relative price variable in the unit value of exports function (Eq. (C)) has correct but low (0.033) and statistically insignificant coefficient (with a t-ratio, .36). It may be recalled that relative price here is the ratio of domestic wholesale price deflated with exchange rate plus unit export subsidy. It measures the relative attractiveness or profitability of supplying the export markets compared to the domestic market. A positive sign for this relative price is essential for policy instruments like devaluation or increase in export subsidy to
have a favourable effect on export price and thereby India's exports.

From the results, a 10% increase in relative price pushes-up unit value of exports by 0.3%. Increase in world price level seems to exert an up-ward pressure on export prices rather than reducing them. A 10% increase in world price level pushes-up the unit value of exports by 7%, indicating a high degree of integration of Indian export market with world market. It may also indicate the potential danger of wholesale transmission of inflationary pressure from abroad. The income coefficients, domestic as well as trading partners' are insignificant and hence are omitted from the regression. An increase in monetary disequilibrium variable, i.e. flow excess demand for real balances, seems to push-up prices of exports rather than reducing them. The coefficient is statistically significant. However, the effect is numerically small (0.0024).

Export Demand:

All the explanatory variables in export demand function are statistically significant. In the order of their t-values, these include, relative export price (defined as the ratio of unit value of exports to world price), income of trading partners, dummy variable representing change in exchange rate regime and lagged dependent variable. There is a significant habit persistence in demand for Indian exports. This equation also satisfies stability condition.
The results indicate that a 10% increase in relative export price would cut demand for Indian exports by 5.5%, while a 10% increase in trading partners' income would have an almost equal but opposite effect. These are short-run responses. The long-run or equilibrium responses are about one and half times larger. The change in exchange rate regime from fixed to flexible seem to have a significant positive effect on Indian exports.

Import Demand:

The import demand function has been well explained by the set of chosen explanatory variables. Most of them are significant, some with very high t-ratios. India's aggregate imports (Eq. (D)) are mainly determined by the current foreign exchange receipts, the monetary disequilibrium variable, relative import price, the lagged dependent variable (stock-adjustment mechanism) and essential imports. The monetary disequilibrium variable has a significant negative effect. The other variables like the domestic real income and lagged foreign assets are also important to a lesser extent. A 10% increase in current foreign exchange receipts would push-up imports by 8%. But, net foreign assets (lagged by one year) have a small negative effect on current imports. A 10% cut in relative import price would increase Indian imports by 1.8%.

Export Supply;
The export supply is specified as a function of real income and lagged exports. The estimated Export supply function shows that the goodness of fit is satisfactory (.93). The coefficients are of correct sign and significant at 5 and 10% level of significance. A 10% increase in the real income would push up the export supply by 5.5%. The coefficient of lagged exports variable is statistically significant with a t-ratio of 3.0\(^3\).

Equations without monetary disequilibrium variable;

Omitting EM variable from the model seem to cause substantial changes in the parameter estimates, particularly their t-ratios though not overall goodness of fit. Absence of EM from unit value of exports equation has resulted in doubling the coefficient of relative export price, decreasing (reducing by half) the coefficient of world price and making domestic income variable statistically significant with almost unitary elasticity. Likewise, the import demand equation also has changed substantially. In particular, the role of lagged dependent variable and essential imports has increased due to the deletion of EM variable as a determinant of imports into India.

\(^3\)The Dh statistic was computed and reported for all the equations which have a lagged dependent variable. As the Dh test is a large sample test, and the sample being small we could not test the presence of serial correlation using the Dh statistic. We realise that some equations might test positive for serial correlation based on DW statistic. This could not be incorporated either.
Thus, the log-linear OLS model is quite satisfactory both in terms of ex-post descriptive power, and signs as well as magnitudes of crucial coefficients. There are some exceptions, of course.

(b) Linear 2SLS Model:

We noted earlier that the CGE model which we are estimating is simultaneous in nature— all current endogenous variables also appear as explanatory variables in some equation or identity. This violates one of the crucial assumption of Ordinary Least Squares (OLS) method of estimation viz., that the explanatory variables be uncorrelated with stochastic disturbance term in each equation. The consequence is that the OLS estimates are no longer unbiased and they suffer from what is commonly known as "simultaneous equation bias". Further, such models are usually over-identified.

For estimating over-identified simultaneous equation models, a modified OLS method known as Two-Stage Least Squares (2SLS) is used. Although this method is called a simultaneous equation method, it is based on single equation approach only. It involves in "purging-out" the endogenous explanatory variables from the correlation with stochastic disturbance term by estimating an instrumental variable for each of such endogenous variable. These instrumental variables are nothing but (OLS) estimated values of respective endogenous variable by regressing each of them on all
the predetermined (explanatory and lagged endogenous) variables in the system. These regressions are called first-stage regressions.

In the second-stage, OLS regressions are run for structural equations by replacing the current endogenous variables on the right-hand side with their instruments. The resultant parameter estimates are known as 2SLS estimates. Strictly speaking, we need to consider the identities as well in the second-stage estimation procedure. Unfortunately, in our case, the identities are non-linear and hence their incorporation into 2SLS estimation seems difficult and therefore not implemented. Further, due to nonavailability of data on import tariffs and export subsidies prior to 1971, 2SLS method could be applied only for a shorter time series viz., 1971-91. We need to remember this while comparing OLS and 2SLS estimates. The linear 2SLS model estimates are reproduced from Appendix:

Sample period: 1971-91

\[
(M/P) = 10.0981 + 0.0012^{**} Y - 253.6045^{*} \pi - 103.7435\pi_2 \\
\]
\[
= 0.6163^{*} (M/P)^t \\
(R^2 = 0.96, DW = 2.38, F = 96, Dh statistic = -1.3887) \tag{A}
\]

\[
X^d = -9.0555 + 1.2733 YW + 0.8277^{*} X_{t-1} ... \tag{B}
\]

\[
(-.84) \quad (1.38) \quad (5.14)
\]
\[ R^2 = 0.86, \quad DW = 2.20, \quad F = 66, \quad Dh = -0.6449 \]

\[ PX_2 = -101.2979^* + 0.0016^* Y + 0.5653^{**} X_{-1} \]
\[ (-13.1) \quad (9.63) \quad (2.56) \]

\[ ...........(C) \]

\[ R^2 = 0.98, \quad DW = 1.68, \quad F = 441 \]

\[ I = 2.7063 + 1.0045^* (XPX_2^* + KI^*)/PM^2 - 0.2040^{**}(R/PM^s)_{-1} \]
\[ (0.73) \quad (40.40) \quad (-2.1) \]

\[ - 0.4372^* EM \quad .................(D) \]
\[ (-5.37) \]

\[ R^2 = 0.99, \quad DW = 2.04, \quad F = 561 \]

\[ X_2 = -13.9709 + 0.0005^* Y + 0.3841^{***} X_{-1} \]
\[ (-1.8) \quad (3.03) \quad (1.73) \]

\[ R^2 = 0.99, \quad DW = 2.10, \quad F = 53.32 \]

* indicates 1% level of significance
** indicates 5% level of significance
*** indicates 10% level of significance

Broadly, in an absolute sense, the 2SLS estimates are satisfactory in terms of goodness of fit, expected signs, magnitudes and t-ratios of coefficients. All the equations satisfy stability condition as well. However, when compared to OLS results, the 2SLS estimates seem less robust—goodness of fit and t-ratios are lower overall. This implies that the precision of 2SLS estimates is lower compared to OLS estimates. This could
be due to several reasons—difference in length of time series, "true" structural model may not be simultaneous but we are imposing this property on the model, and ignoring identities in the model.

The linear model using OLS and 2SLS methods also seem to be strong contenders in providing a good description of the historical data. On the basis of pure statistical criteria, it would be difficult to ignore these estimates. Infact, we propose to use these estimates for undertaking policy analysis in the next chapter.
Fig 5.4 WHOLESALE PRICE INDEX

Fig 5.4: IMPORTS VOLUME
Fig 5.5: EXPORTS VOLUME

Fig 5.6: UNIT VALUE OF EXPORTS
Fig 5.7: UNIT VALUE OF IMPORTS

Fig 5.8: NOMINAL EXCHANGE RATE
## APPENDIX V-I

### DATA LISTING

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Abreviations used

SUB = Export subsidies in rupees crores  
TAR = Import tariffs in rupees crores  
MON SUP = Money supply (ML) in rupees crores  
PRI IND = Wholesale price index (1980-81=100)  
Y = Real national income in rupees 000' crores (1980-81 prices)  
YW = Real GNP of trading partners in US dollars  
RBR = Foreign exchange assets of RBI in rupees
EXR = Nominal exchange rate
PW = World price index
RM = Reserve money in rupees crores
MPS = Import value in crores of rupees
XPS = Export value in crores of rupees
UVE = Unit value index of exports
UVI = Unit value index of imports
EXRR = Real effective exchange rate
EXRN = Nominal effective exchange rate.
APPENDIX V-I LINEAR OLS ESTIMATES:

Sample period: 1962-91

\[(\text{M/P}) = 6.5208 + 0.0012* \ Y - 210.7588* \pi - 31.9641\pi_1 \]

\[-82.9325 \pi + 0.6304 * \ (\text{M/P})_1 \]

\[R^2 = 0.98, \ DW = 1.96, \ F = 235.2, \ Dh statistics = 0.185\]

\[X^d = 11.4003 - 8.7544** \ (\text{PX/PW})^s + 1.3069** \ YW + 0.6651 \ X_1 \]

\[+ 5.2544 \text{ DUMEXR} \]

\[R^2 = 0.92, \ DW = 1.86, \ F = 97.92, \ Dh statistic = 0.64\]

Sample period: 1971-91

\[\text{PX}^s = -27.3792 + 2.1793 \ (\text{P/(E+s)}) + 0.8945* \ PW \]

\[+ 1.9639 \ YW + 0.2867 \ X + 0.2061** \ EM + 12.3209** \text{ DUMEXR} \]

\[R^2 = 0.99, \ DW = 2.63 \ F = 231, \ Dh statistic = -1.50\]

\[I = -62.8179 - 0.5574* \ (\text{PM}^s(E+t)/\text{P}) + 0.0011* \ Y - 0.4244* \ EM \]

\[+ 0.5992* \ ((\text{XPX}^s + \text{KI}^s)/\text{PM}^s) - 0.1650* \ (R/\text{PM}^f) + 0.1657* \ I \]

\[R^2 = 0.99, \ DW = 2.02\]

\[X^s = -13.9709 + 0.0005* \ Y + 0.3841*** \ X_1 \]

\[R^2 = 0.90, \ DW = 2.10, \ F = 91, \ Dh statistic = -0.2345\]

* indicates 1% level of significance
** indicates 5% level of significance
*** indicates 10% level of significance
Without EM

\[
\begin{align*}
\text{PX}^2 &= -27.0992 + 0.7374 \text{ PW} + 0.0007 \ Y + 11.4319 \ \text{DUMEXR} \\
R^2 &= 0.98, \ DW = 2.04, \ F = 277.67
\end{align*}
\]

\[
\begin{align*}
\text{I} &= -7.5205 - 0.5442*(\text{PM}*(E+t)/P) + 0.8708*(\text{XPX}_s+\text{KI}_s)/\text{PM}_s \\
&+ 0.1579 (\text{R}/\text{PM})_{-1} + 0.2451_{-1}** \ I - 7.6385 \ \text{DUMEXR} \\
R^2 &= 0.99, \ DW = 1.78, \ F = 231, \ \text{Dh statistic} = 0.603
\end{align*}
\]

\[
\begin{align*}
\text{X}^2 &= -13.9709 + 0.0005* \ Y + 0.3841*** \text{X}_1 \\
R^2 &= 0.90, \ DW = 2.10, \ F = 91, \ \text{Dh statistic} = -.2345
\end{align*}
\]

Sample period 1962-89

\[
\begin{align*}
(\text{M/P}) &= 16.2598 + 0.0013* \ Y - 196.4479* \pi - 40.5878 \pi_{-1} \\
&+ 89.3873*** \pi_{-2} + 0.5556* (\text{M/P})_{-1} \\
R^2 &= 0.97, \ DW = 1.90, \ F = 142.27, \ \text{Dh statistic} = .439
\end{align*}
\]

\[
\begin{align*}
\text{XD} &= 16.7782 - 8.1092* (\text{PX}^2/\text{FW}) + 1.3465* \ YW + 0.4348** \ X_{-1} \\
&+ 11.5103* \ \text{DUMEXR} \\
R^2 &= 0.96, \ DW = 1.68, \ F = 138, \ \text{Dh statistic} = 1.793
\end{align*}
\]

Sample period: 1971-89

\[
\begin{align*}
\text{PX}^2 &= -44.8580 + 4.5389** (\text{P}/(\text{E}4-\text{s})) + 0.8566* \ PW \\
&+ 0.0007***Y - 0.3241*** \text{X}_{-1} + 0.1712* \ \text{EM} + 10.3524* \ \text{DUMEXR} \\
R^2 &= 0.99, \ DW = 2.23 \ F = 198, \ \text{Dh statistic} = -.7331
\end{align*}
\]

* indicates 1% level of significance
** indicates 5% level of significance
*** indicates 10% level of significance
\[ I = -61.1818 - 0.5259 \cdot \left( \frac{PM}{E^4t/p} \right) + 0.0011 \cdot Y - 0.4201 \cdot EM \]
\[ (-4.49) \quad (-4.83) \quad (4.51) \quad (-10.33) \]
\[ + 0.5969 \cdot \left( \frac{XPS^2KI^5}{PM} \right) - 0.1665 \cdot \left( \frac{R/PM}{s} \right) + 0.1722 \cdot I_F \]
\[ (6.62) \quad (-3.76) \quad (2.90) \]
\[ R^2 = 0.99, \; DW = 1.82, \; F = 198 \]

\[ X^2 = 16.1566 + 0.8086 \cdot \left( \frac{PX}{(E+S)/P} \right) + 0.4189 \cdot X_1 - 0.0565 \cdot EM \]
\[ (2.94) \quad (3.49) \quad (2.28) \quad (-1.14) \]
\[ + 5.8680 \cdot DUMEXR \quad (1.67) \]
\[ R^2 = 0.94, \; DW = 2.54, \; F = 84, \; Dh statistic = -1.9685 \]

Without EM

\[ PX^2 = -91.8728 + 4.5947 \cdot \left( \frac{P/(E+s)}{s} \right) + 0.3793 \cdot PW \]
\[ (-2.45) \quad (1.78) \quad (1.40) \]
\[ + 0.0015 \cdot Y - 0.4794 \cdot X_1 + 11.5416 \cdot DUMEXR \]
\[ (3.68) \quad (-2.15) \quad (2.75) \]
\[ R^2 = 0.99, \; DW = 1.55, \; F = 257.4, \; Dh statistic = 3.996 \]

\[ I = -9.6548 - 0.2223 \cdot \left( \frac{PM}{E+t}/P \right) + 0.8690 \cdot \left( \frac{XPX^2+KI^5}{PM} \right) \]
\[ (-2.48) \quad (-1.31) \quad (12.24) \]
\[ + 0.1338 \cdot \left( \frac{R/PM}{s} \right) + 0.1505 \cdot I_1 - 17.6405 \cdot DUMEXR \]
\[ (1.63) \quad (1.43) \quad (-2.96) \]
\[ + 0.7009 \cdot I_F \quad (5.18) \]
\[ R^2 = 0.99, \; DW = 2.24, \; F = 198, \; Dh statistic = -0.5886 \]

\[ X^2 = 13.7525 + 0.7051 \cdot PX^2(E+s)/P \] + 0.5102 \cdot X_1 + 4.7354 \cdot DUMEXR
\[ (2.69) \quad (3.27) \quad (3.05) \quad (1-39) \]
\[ R^2 = 0.94, \; DW = 2.43, \; F = 95, \; Dh statistic = -1.3687 \]

* indicates 1% level of significance
** indicates 5% level of significance
*** indicates 10% level of significance
Sample period: 1962-87

\[
(M/P) = 19.1426 + 0.0013 \ Y - 190.2529 \ \pi - 44.3993 \ \pi_1
\]

\[
(1.53) \quad (3.44) \quad (-3.36) \quad (-0.85)
\]

\[
-88.1564**\pi_2 + 0.5259* (M/P)_1
\]

\[
(-1.85) \quad (3.14)
\]

\[R^2= 0.95, \ DW = 1.88, \ F = 96, \ Dh \ statistic = 0.59\]

\[X^d = 22.6939 - 8.1583* (P/Xs /PW) + 1.2039* YW + 0.3072** X_{-1}
\]

\[
(3.95) \quad (-3.80) \quad (3.10) \quad (2.08)
\]

\[+ 15.2390* \ \text{DUMEXR}
\]

\[
(4.31)
\]

\[R^2= 0.96, \ DW = 2.30, \ F = 126, \ Dh \ statistic = -1.1606\]

Sample period: 1971-87

\[PX^s = -78.2959 + 7.1084* (P/(E+s)) + 0.5915** PW
\]

\[
(-2.48) \quad (3.45) \quad (2.36)
\]

\[+ 0.0010** \ Y - 0.2952***X_{-1} - I - 0.1537* \ EM + 10.0874* \text{DUMEXR}
\]

\[
(2.90) \quad (-1.92) \quad (3.51) \quad (3.66)
\]

\[R^2= 0.99, \ DW = 2.86, \ F = 165, \ Dh \ statistic = -1.8026\]

\[I = -64.9708 - 0.5859* (PM^*(E+t)/P) + 0.0012* \ Y + 0.2054* I_F
\]

\[
(-4.51) \quad (-5.71) \quad (4.64) \quad (3.43)
\]

\[+ 0.5623* (XPX^s +KI^s)/PM^s - 0.1716* \ (R/PM^s)_1 - 0.4118* \ EM
\]

\[
(6.08) \quad (-4.32) \quad (-11.21)
\]

\[R^2 = 0.99, \ DW = 1.73, \ F = 165\]

\[X^s = 52.2244 + 2.6906**(PX^s (E+s)/P) - 0.0008**Y - 0.0972 \ \text{EM}
\]

\[
(2.88) \quad (2.78) \quad (-2.32) \quad (-1.74)
\]

\[+ 0.7318* X_{-1}
\]

\[
(4.20)
\]

\[R^2= 0.93, \ DW = 2.95, \ F = 165, \ Dh \ statistic = -2.8113\]

* indicates 1% level of significance
** indicates 5% level of significance
*** indicates 10% level of significance
Without \( EM \)

\[
\begin{align*}
\text{PX'} & = -141.4899 + 8.6234* \frac{(P/(E+s))}{(E+s)} + 0.0019 \ Y \\
& \quad (-13.64) \quad (4.61) \quad (16.78) \\
& \quad - 0.3900*** \ X^{-1} + 10.3923* \text{DUMEXR} \\
& \quad (-1.98) \quad (3.12)
\end{align*}
\]

\[ R^2 = 0.99, \quad DW = 1.97, \quad F = 297, \quad \text{Dh statistic} = 0.106 \]

\[
\begin{align*}
I & = -8.7167 - 0.2843 \frac{(PM^s(E+t)/P)}{(E+t)} \\
& \quad (-1.87) \quad (-1.21) \\
& \quad + 0.8580* \frac{(XPXs+Ks^2)/PM^s}{PM^s} + 0.1273 \frac{(R/PMs)_{-1}}{PMs} + 0.1640 \text{I}_{-1} \\
& \quad (10.21) \quad (1.42) \quad (1.26) \\
& \quad - 16.0969 \text{DUMEXR} + 0.7062 \text{I}_F \\
& \quad (-2.14) \quad (4.58)
\end{align*}
\]

\[ R^2 = 0.98, \quad DW = 2.14, \quad F = 81.67, \quad \text{Dh statistic} = -.3415 \]

(a) Log-linear OLS Model

Sample period: 1962-91

\[
\begin{align*}
\text{In} \ (M/P) & = -2.4931* \ 0.3903 \ \text{In} \ Y - 0.8919* \ \pi - 0.1539\pi_{-1} \\
& \quad (-2.95) \quad (2.84) \quad (-4.59) \quad (-0.88) \\
& \quad -0.2790*** \pi_2 + 0.6623* \text{In} \ \frac{M/P}{M/P} \\
& \quad (-1.74) \quad (4.75)
\end{align*}
\]

\[ R^2 = 0.98, \quad DW = 1.99, \quad F = 215.6, \quad \text{Dh statistic} = 0.0424 \]

\[
\begin{align*}
\text{In} \ X^d & = 1.4531 - 0.5495* \text{In} \ (PX^d/PW) + 0.5230* \text{In} \ YW \\
& \quad (3.93) \quad (-4.46) \quad (3.58) \\
& \quad + 0.2965 \text{In} \ X_{-1} + 0.2885 \text{DUMEXR} + 0.0024 \text{EM} \\
& \quad (2.07) \quad (3.43) \quad (3.87)
\end{align*}
\]

\[ R^2 = 0.95, \quad DW = 1.40, \quad F = 138, \quad \text{Dh statistic} = 0.0424 \]

* indicates 1% level of significance
** indicates 5% level of significance
*** indicates 10% level of significance
Sample period: 1971-91

\[ \ln \text{PX} = 1.4281^* + 0.0330 \ln \left( \frac{P}{E+} \right) + 0.7378^* \ln \text{PW} + 0.0024^* \text{EM} + 0.1334^* \text{DUMEXR} \]
\[ (6.94) \quad (0.36) \quad (27.50) \]
\[ R^2 = 0.99, \quad DW = 1.80, \quad F = 346.5 \]

\[ \ln \text{I} = -3.4873^{***} - 0.1796^* \ln \left( \frac{\text{PM}}{E+t}/\text{P} \right) + 0.3492 \ln \text{Y} + 0.8067^* \ln \left( \frac{\text{XPX}+\text{KI}}{\text{PM}} \right) - 0.0203 \ln \left( \frac{\text{R}}{\text{PM}} \right) \]
\[ (-1.61) \quad (-4.27) \quad (1.50) \]
\[ (10.0) \quad (-1.19) \]
\[ + 0.0636^{**} \ln \text{I}_t + 0.1753^* \ln \text{I}_t - 0.0036^* \text{EM} \]
\[ (2.24) \quad (2.46) \quad (-6.14) \]
\[ R^2 = 0.99, \quad DW = 2.25, \quad F = 198, \quad \text{Dh statistic} = -0.61 \]

\[ \ln \text{XS} = -2.5386 + 0.1243 \ln \left( \frac{\text{PX}}{E+s}/\text{P} \right) + 0.3637^{***} \ln \text{Y} + 0.5089 \ln \text{X} \]
\[ (-0.46) \quad (0.72) \quad (1.32) \]
\[ (-0.59) \]
\[ R^2 = 0.93, \quad DW = 2.26, \quad F = 113.7 \]

Without EM

\[ \ln \text{PX} = -7.8173^{***} + 0.0667 \ln \left( \frac{P}{E+s} \right) + 0.3543^* \ln \text{PW} \]
\[ (-1.66) \quad (2.06) \]
\[ + 0.9199^{**} \ln \text{Y} + 0.2154^* \text{DUMEXR} \]
\[ (2.05) \quad (4.13) \]
\[ R^2 = 0.99, \quad DW = 1.21, \quad F = 346.5 \]

\[ \ln \text{I} = -1.4814 - 0.2903^* \ln \left( \frac{\text{PM}}{E+t}/\text{P} \right) + 0.1195 \ln \text{Y} + 0.6695^* \ln \left( \frac{\text{XPX}+\text{KI}}{\text{PM}} \right) + 0.0442^{***} \ln \left( \frac{\text{R}}{\text{PM}} \right) \]
\[ (-0.36) \quad (-4.01) \quad (0.27) \quad (4.54) \quad (1.72) \]
\[ + 0.4291^* \ln \text{I}_t - 0.1609^* \ln \text{I}_t \]
\[ (3.88) \quad (3.57) \]
\[ R^2 = 0.99, \quad DW = 1.80, \quad F = 98, \quad \text{Dh statistic} = .5314 \]

* indicates 1% level of significance

** indicates 5% level of significance

*** indicates 10% level of significance
\[
\ln X^8 = -4.6819* + 0.5557 \ln Y + 0.5783* \ln X_{-1} \\
(-2.10) \quad (2.18) \quad (3.00)
\]

\[ R^2 = 0.93, DW = 2.11, F = 120, Dh statistic = -.54 \]

Sample period: 1962-89

\[
\ln (M/P) = -2.5420 + 0.4191* \ln Y - 0.8476* \pi - 0.1783 \pi_{-1} \\
(-3.02) \quad (3.00) \quad (-4.35) \quad (-1.02)
\]

\[-0.2957** \pi_2 + 0.6099 \ast \ln (M/P)_{-1} \\
(-1.86) \quad (4.17)\]

\[ R^2 = 0.98, DW = 1.97, F = 235.2, Dh statistic = .1255 \]

\[
\ln X^d = 1.8565 - 0.5168 \ast \ln (P_{Xs}/PW) + 0.5391 \ast \ln YW \\
(4.69) \quad (-4.52) \quad (3.94)
\]

\[+ 0.3696 \ast \text{DUMEXR} + 0.1604 \ln X_{-1} \]
\[ (4.21) \quad (1.04)\]

\[ R^2 = 0.95, DW = 1.59, F = 150, Dh statistic = 1.876 \]

Sample period 1971-89

\[
\ln PX^s = 1.2286 + 0.1592 \ln (P/(E+s)) + 0.7381 \ast \ln PW \\
(5.78) \quad (1.38) \quad (27.91)
\]

\[+ 0.0026 \ast \text{EM} + 0.1248 \ast \text{DUMEXR} \]
\[ (4.56) \quad (3.18)\]

\[ R^2 = 0.99, DW = 1.41, F = 396 \]

\[
\ln I = -5.7506 - 0.2144 \ast \ln (PM_{s}(E+t)/P) + 0.5833*** \ln Y \\
(-2.02) \quad (-4.98) \quad (1.94)
\]

\[+ 0.6881 \ast \ln ((XPX^s+KI^s)/PM^d) + 0.1899** \ln I_{-1} \]
\[ (6.77) \quad (2.70)\]

\[- 0.0030 \ast \text{EM} + 0.0902 \ast \ln I_F \]
\[ (-6.31) \quad (3.25)\]

\[ R^2 = 0.99, DW = 2.06, F = 183.86, Dh statistic = -.14 \]

* indicates 1% level of significance
** indicates 5% level of significance
*** indicates 10% level of significance
In $X^s = 10.2616 + 0.6991 \times \ln \left(\frac{PX^s}{P} \right) - 0.8731 \times \ln Y$
\begin{align*}
   &+ 0.4737 \times \ln X_{-1} - 0.0016 \times EM \\
   &R^2 = 0.96, \quad DW = 2.83, \quad F = 76.09, \quad Dh statistic = -1.41
\end{align*}

Without EM
\begin{align*}
   \ln PX^s &= -14.4157 + 0.3940 \times \ln \left(\frac{P}{E+s} \right) + 0.1185 \times \ln PW \\
   &+ 1.5237 \times \ln Y + 0.2296 \times DUMEXR \\
   &R^2 = 0.99, \quad DW = 1.01, \quad F = 196
\end{align*}

In $I = -5.8902 - 0.3115 \times \ln \left(\frac{PM(E+t)}{P} \right) + 0.5843 \times \ln Y$
\begin{align*}
   &+ 0.5017 \times \ln \left(\frac{XPX^s + KI^s}{PM} \right) + 0.0442 \times \ln \left(\frac{R/P}{M} \right) \\
   &R^2 = 0.98, \quad DW = 1.86, \quad F = 231, \quad Dh statistic = 1.776
\end{align*}

Sample period: 1962-87

In $M = -2.5486 + 0.5843 \times \ln Y - 0.8384 \times \pi - 0.1832 \times \pi_{-1}$
\begin{align*}
   &- 0.2937 \times \pi_{-2} + 0.6003 \times \ln \left(\frac{M}{P} \right) \\
   &R^2 = 0.96, \quad DW = 1.96, \quad F = 129.33, \quad Dh statistic = 0.1498
\end{align*}
\[
\ln X^d = 1.9663 - 0.5010\ln (\text{PX}_s / \text{PW}) + 0.5136\ln YW
\]
\[
+ 0.3833\text{DUMEXR} + 0.1445\ln X_1
\]
\[
R^2 = 0.94, \text{DW} = 1.63, F = 82.25, \text{Dh statistic} = 1.623
\]

Sample period 1971–87

\[
\ln \text{PX}_s = -5.3240 + 0.4271\ln \left(\frac{P}{(E+s)}\right) + 0.4555\ln \text{PW}
\]
\[
+ 0.6212\ln Y + 0.0021\text{EM} + 0.1750\text{DUMEXR}
\]
\[
R^2 = 0.99, \text{DW} = 2.33, F = 217.8
\]

\[
\ln I = -5.9831 - 0.2163\ln \left(\frac{\text{PM}_s(E+t)}{P}\right) + 0.6081\ln Y
\]
\[
+ 0.6816\ln \left(\frac{\text{XPX}_s + \text{KI}_s}{\text{PM}_s}\right) + 0.1849\ln I_1
\]
\[
- 0.0030\text{EM} + 0.0913\ln I_F
\]
\[
R^2 = 0.99, \text{DW} = 2.01, F = 165, \text{Dh statistic} = -0.0225
\]

\[
\ln X^s = 10.5924 + 0.6844\ln \left(\frac{\text{PX}_s}{\text{PM}_s}\right) + 0.5143\ln X_1
\]
\[
- 0.0015\text{EM} - 0.9124Y
\]
\[
R^2 = 0.95, \text{DW} = 2.94, F = 72, \text{Dh statistic} = -2.6608
\]

WITHOUT EM

\[
\ln \text{PX}_s = -13.6302 + 0.4590\ln \left(\frac{P}{(E+s)}\right) + 0.1199\ln \text{PW}
\]
\[
+ 1.4450\ln Y + 0.2428\text{DUMEXR}
\]
\[
R^2 = 0.99, \text{DW} = 1.20, F = 147
\]
\[ \ln I = -3.6934 - 0.3025 \ln (PM_s(E+t)/P) + 0.3544 \ln Y \]
\[ \quad (0.42) \quad (-3.44) \quad (0.38) \]
\[ + 0.5664*** \ln (XPX^2+K1^2)/PM_s + 0.4194** \ln I_{-1} \]
\[ \quad (2.04) \quad (2.63) \]
\[ + 0.1768* \ln I_{\bar{F}} + 0.0430 \ln (R/PM_s) \]
\[ \quad (3.41) \quad (1.58) \]
\[ R^2 = 0.98, \quad DW = 1.86, \quad F = 81.67, \quad Dh statistic = .3833 \]

\[ \ln X = 7.2731 + 0.4573** \ln PXs(E+s)/P) - 0.6196*** \ln Y \]
\[ \quad (2.06) \quad (2.71) \quad (-1.77) \]
\[ + 0.6589* \ln X_{-1} \]
\[ \quad (4.03) \]
\[ R^2 = 0.94, \quad DW = 2.57, \quad F = 82.33, \quad Dh statistic = -1.5901 \]

**LIKEAR 2SLS**

Sample period 1971-87

\[ (M/P) = 41.2290 + 0.0023 Y - 205.6650\pi_1 \]
\[ \quad (1.37) \quad (8.53) \quad (-2.81) \]
\[ R^2 = 0.84, \quad DW = 1.77, \quad F = 43 \]

\[ X_d = 98.9121 - 31.2144 (PX^s/PW) + 19.7543 DUMEXR \]
\[ \quad (13.5) \quad (-8.32) \quad (9.26) \]
\[ R^2 = 0.93, \quad DW = 1.83, \quad F = 109.67 \]

\[ PX^s = -57.2433 + 5.9047 (P/(E+s)) + 0.0008 Y + 0.7504 PW \]
\[ \quad (-1.33) \quad (1.92) \quad (1.76) \quad (2.29) \]
\[ - 0.3238 X^{-1} + 0.1616 EM + 11.0766 DUMEXR \]
\[ \quad (-1.71) \quad (2.90) \quad (3.20) \]
\[ R^2 = 0.99, \quad DW = 2.14, \quad F = 165, \quad Dh statistic = -0.4675 \]

* indicates 1% level of significance
** indicates 5% level of significance
*** indicates 10% level of significance
I = -5.8397 + 0.9522 \left( \frac{XPX_s + KI_s}{PM_s} \right) + 0.5818 I_p - 0.1580 EM \\
\begin{align*}
&\text{(4.15)} & \text{(26.48)} & \text{(-2.15)} \\
&\text{(-3.8)}
\end{align*}
- 16.4398 DUMEXR \\
R^2 = 0.99, \quad DW = 2.11, \quad F = 297

X^s = 13.4111 + 0.4405 \frac{PX^s(E+s)}{P} + 0.5870 X_{-1} \\
\begin{align*}
&\text{(2.65)} & \text{(1.37)} & \text{(3.34)} \\
&\text{(1.57)}
\end{align*}
+ 5.5919 DUMEXR \\
R^2 = 0.92, \quad DW = 2.82, \quad F = 57.57, \quad \text{Dh statistic} = -2.4523

Sample period 1971-89

\begin{align*}
(M/P) &= 31.5337 + 0.0010 Y - 265.1536 \pi - 110.3469 \pi^2 \\
&\text{(1.58)} & \text{(2.68)} & \text{(-4.28)} & \text{(-1.97)} \\
&\text{(3.88)}
\end{align*}
+ 0.6086 \frac{M/P}{(Y/P)} \\
R^2 = 0.94, \quad DW = 1.99, \quad F = 84, \quad \text{Dh statistic} = 0.0298

X^d = 2.1562 + 1.0182 X_{-1} \\
\begin{align*}
&\text{(0.47)} & \text{(13.56)}
\end{align*}
R^2 = 0.91, \quad DW = 2.05, \quad F = 171.89, \quad \text{Dh statistic} = -0.0922

PX^s = 16.6992 + 1.2287 PW \\
\begin{align*}
&\text{(9.07)} & \text{(45.3)}
\end{align*}
+ 0.2166 EM + 10.3786 DUMEXR \\
\begin{align*}
&\text{(5.46)} & \text{(4.3)}
\end{align*}
R^2 = 0.99, \quad DW = 1.33, \quad F = 495

I = 2.4286 + 1.0027 \left( \frac{XPX^s + KI^s}{PM^s} \right) - 0.1914 \left( \frac{R}{PM} \right)^s_{-1} \\
\begin{align*}
&\text{(0.47)} & \text{(26.3)} & \text{(-1.58)} \\
&\text{(-4.00)}
\end{align*}
- 0.4062 EM \\
R^2 = 0.98, \quad DW = 1.95, \quad F = 245
\[ x^2 = 27.2783 + 1.2761 \frac{PX^2 (E+s)}{P} - 0.0003 \ y + 0.7842 \ x_{-1} \]
\[ \frac{(2.32)}{(2.76)} \frac{(E+s)}{P} - 0.0003 \ y + 0.7842 \ x_{-1} \]

\[ R^2 = 0.94, \ \text{DW} = 2.64, \ F = 95, \ \text{Dh statistic} = -2.0985 \]

Sample period 1971–91

\[ (M/P) = 10.0981 + 0.0012 \ y - 253.6045 \ \pi - 103.7435 \ \pi_{-2} \]
\[ \frac{(0.49)}{(2.70)} \frac{(E+s)}{P}_{-1} \]

\[ + 0.6163 \ (M/P)_{-1} \]
\[ (3.62) \]

\[ R^2 = 0.96, \ \text{DW} = 2.38, \ F = 96, \ \text{Dh statistic} = -1.3887 \]

\[ X^d = -9.0555 + 1.2733 \ YW + 0.8277 \ X \]
\[ \frac{(-.84)}{(1.38)} \frac{(E+s)}{P}_{-1} \]

\[ R^2 = 0.86, \ \text{DW} = 2.20, \ F = 66, \ \text{Dh statistic} = -0.6449 \]

\[ PX^3 = -101.2979 + 0.0016 \ y + 0.5653 \ X \]
\[ \frac{(-13.1)}{(9.63)} \frac{(E+s)}{P}_{-1} \]

\[ R^2 = 0.98, \ \text{DW} = 1.68, \ F = 441 \]

\[ I = 2.7063 + 1.0045 \ \frac{(XP^3 + KI^3)}{PM^3} - 0.2040 \ (R/PM)_{-1} - 0.4372 \ EM \]
\[ \frac{(0.73)}{(40.4)} \frac{(E+s)}{P}_{-1} \]

\[ R^2 = 0.99, \ \text{DW} = 2.04, \ F = 561 \]

\[ X^2 = -13.9709 + 0.0005 \ y + 0.3841 \ x_{-1} \]
\[ \frac{(-1.8)}{(3.03)} \frac{(E+s)}{P}_{-1} \]

\[ R^2 = 0.90, \ \text{DW} = 2.10, \ F = 53.32 \]

* indicates 1% level of significance
** indicates 5% level of significance
*** indicates 10% level of significance