CHAPTER THREE

DATA AND METHODS OF DATA ADJUSTMENTS

In this chapter, we would describe the sectoral classification used in the model, data for variables used for estimating the parameters of the model and methods of adjustment in that data.

The main sources of our data are the various issues of the National Accounts Statistics published by the Central Statistical Organisation.\(^6\) (hereafter referred to as the NAS and CSO, respectively). The second important source of data is the Technical Note on the Sixth Plan of India prepared by the Planning Commission (hereafter referred to respectively, as TN and PC). Some data have been obtained from the Report on Currency and Finance (RCF) published by the Reserve Bank of India (RBI). Besides, data from some other sources have also been used which we would mention wherever necessary.

\(^6\) Since the details of coverage and methodology of compilation of data followed by the CSO are readily available in their publication entitled 'National Account Statistics - Sources and Methodology' (1980), it is unnecessary to reproduce them over here. However, we would mention if something is found necessary. The RBI also gives notes on the data published by them in the RCF.
3.1 Sectoral Classification

The sectoral classification used in our model is quite close to the one followed by the CSO in the NAS. The Planning Commission has also followed a similar classification in the Technical Note with some minor deviations which would be pointed out at appropriate places in the text. A Brief description of the sectors used in our model is presented below. It would be proper to mention that this section draws heavily on the National Account Statistics - Sources and Methodology (1980). The abbreviations used for identifying the sectors and variables in the text are given in brackets alongwith their names.

3.2 Sectors

1. Agriculture (AG): This sector includes (i) growing of field crops, fruits, nuts, seeds and vegetables, (ii) management of tea, coffee and rubber plantations, (iii) growing of trees on farm land and village common lands, (iv) agricultural and horticultural services on a fee or on contract basis such as harvesting, baling, threshing, husking and shelling, preparation of tobacco for marketing, pest destroying and spraying of insecticides etc., pruning, picking, packing and operating irrigation system (including those operated by the government), and (v) ancillary activities of cultivators such as transportation operation of carrying their farm products to

17. The CSO uses the word 'industry' to described a sub-set of the economy where as we use the word 'sector' for the same.
primary markets and activities yielding rental income from farm buildings and farm machine and providing agricultural loans. The sector also covers allied activities such as breeding and rearing of animals and poultry including private veterinary services, production of milk and milk products, slaughtering, preparation and dressing of meat, production of raw hides and skins, eggs, dung, raw wool, honey and silk worm cocoons, hunting and trapping.

The sector perfectly corresponds with the 'Agriculture and Allied Activities' industry in the NAS. It is also similar to the 'Agriculture' industry in the Technical Note.

2. Forestry and Logging (FL): Forestry and Logging cover (i) forestry (gathering of uncultivated forest products, charcoal burning carried out in the forests and the like), and (ii) logging (felling and rough cutting of trees, hewing or rough shaping of poles, blocks, scaffoldings etc.) and transportation of the logs upto the permanent lines of transport. Bamboo, sandal wood, lac, etc. are also included in this sector.

3. Fishing (FS): The coverage of this sector is the same as of the Fishing industry in NAS and the Technical Note. It includes commercial fishing in (i) ocean, coastal and off-shore waters, and (ii) inland waters. This sector includes such activities as catching, tackling and gathering of fish from rivers, irrigation and other canals, lakes,
tanks, inundated tracts etc. The sector also covers, gathering of sea-weeds, sea shells, pear s, sponges and other ocean and coastal water products, subsistence fishing and exploitation of uncultivated plant life in inland waters and artificial ponds, and salting and sun-drying of fish.

4. **Mining and Quarrying (MQ):** Mining and Quarrying cover extraction of solid, liquid and gaseous minerals from underground and surface mines, quarries and oil wells. This sector includes all such supplementary operations (for dressing and beneficiating ores and other crude minerals) as crushing, screening, washing, cleaning, grading, milling, froth floatation, melting, pelletising, topping and other preparations needed to render the material marketable. These activities are, however, covered in this sector only if they are carried out at the mine site. The sector includes also, activities carried out in respect of rock salt, but excludes preparation of salt from sea water by evaporation method which is included in the manufacturing sector.

5. **Manufacturing (MF):** This sector covers all manufacturing and processing units irrespective of whether or not registered under the Factories Act. More specifically, apart from manufacturing and major processing units, this sector includes all the units engaged in making, altering, repairing, ornamenting, finishing, packing, oiling,
washing, breaking-up, demolishing or otherwise treating or adapting any article or substance with a view to its use, sale, transport, delivery or for its disposal. The sector includes also composing types of printing, printing by letter press, lithography, photography, photogravure other similar processing, book binding, constructing or reconstructing or breaking-up of ships and vessels, railway workshops and goods produced in defence establishments. The sector, however, excludes the establishments which are registered under Indian Factories Act but are not engaged in manufacturing activity, e.g., water and sanitary services, recreation and cultural services, personal services, cold storage, mints, ordnance factories, and generation, transmission and distribution of electricity. These establishments, however, are included elsewhere and would be mentioned at appropriate places.

6. **Construction (CN):** The construction sector comprises of contractual as well as non-contractual construction works including those connected with plantation and cultivating of new forests, and orchards. However, the sector does not include demolition activity.

7. **Electricity, Gas and Water Supply (EG):** The coverage of this sector is (i) generation, transmission and distribution of electricity, (ii) manufacture of coal gas by two gas companies, viz., Bombay Gas Company and Oriental Gas Company and that of liquid petroleum gas (LPG) by
petroleum refineries. Distribution of gas to household, industrial, commercial and other users also falls under this sector, and (iii) collection, purification and distribution of water for domestic and industrial consumption. However, operation of irrigation system is excluded from this sector.

8. **Railways (RL):** Railways include transportation by government and non-government railways and services incidental to this means of transport. For this sector, our coverage is similar to that of the Technical Note. Information regarding this sector is available in the NAS under the sub-heading 'Railways' which forms part of the industry named by the CSO as 'Transport, Storage and Communications'.

9. **Transport by Other Means and Storage (OT):** This sector also is a sub-sector of the 'Transport, Storage and Communications' industry in the NAS. Planning Commission, however, considers 'transport by other means' as its 9th sector in its 14-sector classification in the Technical Note named as Other Transport. In the Technical Note 'Storage' is not included in this sector.

   This sector covers mechanised and non-mechanised waterways transport by road (coastal, ocean and inland) and air, services incidental to these transport and storage - storage including warehousing, cold storage, other storage repositories and safe deposits - when such services are offered as independent services.
10. **Communications (CM):** 'Communications' also appears as a sub-sector under the 'Transport, Storage and Communication' in the NAS. It corresponds with the 10th sector in the 14-sector classification of the Technical Note. It includes postal, telephone, telegraph and overseas communication services. Banking services provided by the post-office are excluded from this sector and are classified with the Banking and Insurance sector.

11. **Trade, Hotels and Restaurants (TR):** This sector in our study corresponds to that of the NAS. The Planning Commission excludes Hotels and Restaurants from this sector and classifies it with Public Administration, Defence and Other services. In Planning Commission classification, the 'Storage services' are excluded from 'Transport by other means and Storage' and are included in 'Trade, Storage and Warehousing'.

In our and NAS classifications this sector covers wholesale and retail trade including (a) imports and exports of goods for trading, (b) services rendered by hotels, restaurants, eating houses, cafes, drinking and lodging places, and (c) also the services of purchase and sales agents, brokers and auctioners.

12. **Banking and Insurance (BI):** This sector covers commercial banks, banking departments of the RBI, public non-banking corporations, organised non-banking financial companies, unorganised non-banking institutions (like
professional money lenders and pawn brokers), post office saving and cumulative time deposits and national saving certificates, co-operative societies, and life and other insurance activities.

13. **Real Estate and Ownership of Dwellings (RE):** In the NAS classification, this sector appears to have almost the same coverage as the Technical Note classification. The only deviation is that the Planning Commission does not include Business Services in this sector whereas the NAS does.

In our study, this sector covers ownership of dwellings (occupied residential houses), real estate services, i.e., activities of all types of dealers such as operators, developers and agents connected with the real estate and business services.

14. **Public Administration, Defence and Other Services (SR):** We have aggregated two of the NAS sectors, viz., Public Administration and Defence, and 'Other Services' to form this sector. The aggregation is similar to the Technical Note classification except for services rendered by Hotels and Restaurants etc. These two services are included by the Planning Commission in the sector named as Public Administration Defence and Other Services. In our case, the services provided by Hotels and Restuarants etc., are included in the Trade, Hotels and Restuarants. Thus our
14th sector corresponds to the aggregate of two NAS sectors, viz., Public Administration and Defence and Other Services.

This sector covers services rendered by public administration, defence, medical and health establishments, educational and research institutions. It also includes religious, legal, domestic laundry, dry cleaning and dying, hair-cutting, beautyshops and other personal services, sanitary services etc. recreational and entertainment services and service not elsewhere classified.

To great extent, our sectoral classification is same as that of the NAS except that we have aggregated two services sector of the NAS into one sector. However, ordering and numbering of sectors in our classification is similar to that used by the Planning Commission in the Technical Note but our sectors 9, 11, 13 and 14 do not match perfectly with corresponding sectors of the Technical Note. **We have presented a comparative list of our and Technical Note sectors in table 3.1.**

### 3.3 Data

We now turn to describe in this section the availability and nature of data we have used and also the adjustment that have been made to make data more suitable to our study. For estimating the parameters of the model, we require a time series data for important economic variables at sectoral level and for some variables,
### Table 3.1

**A Comparative List of Sector Classifications**

<table>
<thead>
<tr>
<th>Sector Number</th>
<th>OUR</th>
<th>Of Planning Commission in the Technical Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agriculture</td>
<td>Agriculture</td>
</tr>
<tr>
<td>2</td>
<td>Forestry and Logging</td>
<td>Forestry and Logging</td>
</tr>
<tr>
<td>3</td>
<td>Fishing</td>
<td>Fishing</td>
</tr>
<tr>
<td>4</td>
<td>Mining and Quarrying</td>
<td>Mining and Quarrying</td>
</tr>
<tr>
<td>5</td>
<td>Manufacturing</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>6</td>
<td>Construction</td>
<td>Construction</td>
</tr>
<tr>
<td>7</td>
<td>Electricity, Gas and Water Supply</td>
<td>Electricity, Gas and Water Supply</td>
</tr>
<tr>
<td>8</td>
<td>Railways</td>
<td>Railways</td>
</tr>
<tr>
<td>9*</td>
<td>Transport by other means and Storage</td>
<td>Other Transport (excluding Storage)</td>
</tr>
<tr>
<td>10</td>
<td>Communications</td>
<td>Communications</td>
</tr>
<tr>
<td>11*</td>
<td>Trade, Hotels and Restaurants</td>
<td>Trade, Storage and Warehousing (excludes Hotels and Restaurants)</td>
</tr>
<tr>
<td>12</td>
<td>Banking and Insurance</td>
<td>Banking and Insurance</td>
</tr>
<tr>
<td>13*</td>
<td>Real Estate and Ownership of Dwellings and Business Services</td>
<td>Real Estate and Ownership of Dwelling</td>
</tr>
<tr>
<td>14*</td>
<td>Public Administration, Defence and other services</td>
<td>Public Administration, Defence, and Other Services including services rendered by Hotels and Restaurants etc.</td>
</tr>
</tbody>
</table>

**Note:** Sectors marked with an astrisk are slightly different in the two classifications presented in this table.
at macro level. Apart from these variables we need a series of input-output tables (and some other tables described latter) corresponding to our sector classification. We have first described our data requirement at the macro level and then the sectoral data requirement.

The period for which the data has been considered is from 1960-61\textsuperscript{18} to 1981-82 (both years inclusive). This period has often been referred to as 'our sample period' or 'our reference period' in our text.

The term 'macro data' refers to the national aggregate and covers the economy as a whole whereas the term 'sectoral data' is used for the aggregate for the sector, i.e., total for all the firms, industries etc. in the sector.

3.3.1. Macro Data
(i) Gross Domestic Product at Factor Cost (GDPFC)
The data for GDPFC are available at both current and constant (1970-71) prices (hereafter referred to as

\textsuperscript{18} The data published in the \textit{NAS} pertains to the financial year ended March 31st. Thus, 1960-61 means period between April 1st 1960 and March 31st 1961.
constant prices) in the NAS. However, we have aggregated the sectoral figures for GDP to arrive at the national aggregates for each year. This has been done to avoid any discrepancy in the total of sectoral figures and the given totals.

(ii) **Private Final Consumption Expenditure (PFCEM)**
The data on private final consumption expenditure are also available in the NAS at both current and constant market prices.

(iii) **Government Consumption Expenditure (GFCEM)**
The CSO publishes the data for this variable in the NAS at both current and constant market prices. The same data have been used.

19. The data for the decade of sixties is available at constant 1960-61 prices in the NAS. It has been converted to constant 1970-71 prices by using proportions of the figures for over lapping year, i.e., the proportion for the year 1970-71 for which data are available at both 1960-61 and 1970-71 prices. Mathematically,

\[
x_{70,t} = x_{60,t} \frac{x_{70,71}}{x_{60,70}}
\]

where,

- \(x_{70,t}\) = unknown value of the variables at constant 1970-71 prices for period \(t\).
- \(x_{60,t}\) = known value of the variable at constant 1960-61 prices for period \(t\).
- \(x_{70,71}\) = known value of the variable for the 1970-71 at constant 1970-71 prices.
- \(x_{60,70}\) = known value of the variable for the 1970-71 at constant 1960-61 prices.
(iv) **Indirect Taxes Less Subsidies (INTAX):** Data for indirect taxes less subsidies are published by the CSO in the **NAS** at current prices. The required data is obtained at constant prices as difference between GDP at market prices and GDP at factor cost both considered at constant 1970-71 prices. Thus we have indirect taxes at both current and constant prices obtained from the **NAS**.

(v) **Gross Domestic Capital Formation (GDKF):** Data regarding GDKF are again available in the **NAS** at both current and constant prices for the economy.  

(vi) **Changes in Stocks (CHSTK):** The CSO publishes these data at both current and constant prices in the **NAS** and the same have been used here.

(vii) **Exports (EXPOR):** Data regarding exports at current prices are available in the **NAS**. These data cover exports of merchandise and other commodities (f.o.b), transport and communications in respect of exports, exports other than merchandise, insurance service charges in respect of exports other than merchandise, direct purchases in the domestic market by extra-territorial bodies and direct purchases by non-resident households. Exports of merchandise and miscellaneous commodities constitute more than 80 per cent of the total exports of goods and services.

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20. The terms 'Gross Domestic Capital Formation' and 'Investment' have been used interchangeably throughout the text and refer to the same variable, i.e., 'Gross Domestic Capital Formation.'
The data for exports at constant prices are however not available. We have, therefore, deflated them by the Unit Value Index (UVI), obtained from the RCF published by the RBI, to get their estimate at constant prices. The RCF also provides data on exports of merchandise (f.o.b) miscellaneous commodities but we have not considered it because we want to confine ourselves to the NAS, as the change in the source of data may lead to various comparability and coverage problems.

(viii) Imports (IM): The data regarding imports are available only at current prices and constant prices estimates are obtained by deflating them with the UVI for imports taken from the RCF. These data cover imports of merchandise and miscellaneous commodities (c.i.f.), transport services on merchandise imports by resident industries, other transport and communication services

21. We have taken the UVI for exports from the RCF for deflating our exports at current prices because we do not have any other suitable deflator available for this purpose. This UVI covers prices of more than 80 per cent of our exports and we may use this index for deflation assuming that the prices of rest of the exports, which are less than 20 per cent, follow similar changes. Even if they don't, our estimates of exports at constant prices are expected to be quite close to the actual value of exports at constant prices because of more than 80 per cent coverage of actual prices by the UVI.

22. Use of UVI for imports obtained from the RCF may be justified on the ground similar to those on which it has been justified for the exports.
by non-residents, insurance charges on imports other than merchandise, services by non-residents, direct purchase abroad by resident households, direct purchases abroad on current account by government and non-cash inflow. Imports of merchandise and miscellaneous commodities constitute more than 90 per cent of the total imports of goods and services.

Value of the imports given in the RCF has not been considered for the reasons given in respect of exports. However, import figures published by the RBI in the RCF are used to split the imports given in the NAS into two components, viz., (a) Oil Imports (MO) which include imports of petroleum crude, partly refined crude oil, petroleum products (excluding fertilisers), lubricant and related materials, and (b) General Imports (MG), which include all imports other than MO. (These are often referred to as imports other than oil).

For obtaining the break-up of IM given in the NAS into MO and MG, we first converted imports (IM) to constant prices using the UVI for imports. Then the value of MO given in the RCF if subtracted from the total imports given in the same report and MG is obtained as residual. The values of MO and MG so obtained are brought to constant prices by deflating them with their respective unit value indices available in the same
source. Now the proportions of $\bar{M}G$ and $\bar{M}O$ in $IM$ are worked out and applied to the $NAS$ figures of total imports which have already been brought at constant prices. We have obtained the estimates of $\bar{M}O$ and $\bar{M}G$ at constant prices which constitute $IM$ given in the $NAS$. Such splitting up of imports given in the $NAS$ (using the proportions of $\bar{M}O$ and $\bar{M}G$ obtained from the $RCF$) assume that these proportions are valid for the $NAS$ data. We may safely make this assumption as the coverage by the $RCF$ accounts for more than 90 per cent of the $NAS$ data.

(ix) Statistical Discrepancies: The CSO presents statistical discrepancies from 1970-71 onwards, in the table entitled 'Gross Domestic Product and Expenditure'. These discrepancies are observed when attempt is made to equate GDP at market prices with the expenditure on GDP, according to the national accounting identity

\[ P_2 = \frac{m_2 p_1 p}{P_1 M - p m_1} \]

where

- $P_2$ = unknown UVI for MG
- $m_1$ = known $\bar{M}O$ at current prices
- $m_2$ = known $\bar{M}G$ at current prices
- $M$ = known IM at current prices
- $P_1$ = known UVI for $\bar{M}O$
- $p$ = known UVI for IM
which states that GDP at market prices equals private consumption, plus government consumption, plus gross fixed capital formation, plus changes in stocks, plus exports, minus imports. These discrepancies, however, are within ± 3 per cent range of the GDP at market prices when considered at current prices. At constant prices these discrepancies reduce to less than ± 2 per cent of the GDP at market prices.

However, the CSO does not publish any such discrepancies in its pre-1970 issues of the NIS and the data presented in these issues satisfy the national income identity mentioned above. Perhaps, such discrepancies were being absorbed into one or more components of this identity in those days.

For post-seventy period, we have matched both sides of the national income identity by absorbing the discrepancies proportionally into four components of the identity, viz., private consumption, government consumption, gross domestic fixed capital formation and changes in stocks. Such an adjustment implies an assumption that the discrepancies are arising due to uniform under or over estimation of the figures for these four variables.

(x) **Money Supply (MONEYS)**: The information regarding money supply is published by the RBI in the RCF. It is presented according to four definitions M1, M2, M3 and M4, all four at current prices. Each of these definition has different and also overlapping information and pertains
to stock of money at the end of period, i.e., March 31st. We consider the narrow definition M1 for our purpose as it is supposed to be the component of money which influences the prices most. Most of the models constructed for the Indian economy use this definition of money supply in connection with prices. The definition M1 covers, notes in circulation, circulation of rupee coins including ten rupee commemorative coins and two rupee coins, circulation of small coins, cash on hand with banks, net demand deposits of banks and other deposits with the RBI. However, the data before and after January 1978 are not strictly comparable due to change in accounting method adopted by commercial banks after that time. This change in accounting shows a decline in M1, because the commercial banks started showing large proportion of demand deposits as time liabilities from January 1978 onwards.

(xi) Macro Deflators: Macro price deflators have been worked out for gross domestic product using the following formula.

\[
P_{\text{gdp}} = \frac{\sum_{i=1}^{n} \bar{q}_i P_i}{\sum_{i=1}^{n} \bar{q}_i}
\]

Where \( P_{\text{gdp}} \) is the unknown price deflator for gross domestic product (at factor cost), \( \bar{q}_i \) is the

sectoral gross value added (at factor cost) at constant 70-71 prices and \( p_1 \) is the implicit price deflator for \( g_1 \). Deflators for other macro variables have been worked out by dividing their value at current prices by respective value at constant prices.

3.3.2. **Sectoral Data:**

(i) **Gross Output (VOPF):** The term gross output has often been used in the literature to describe variables which are conceptually different. For example Krishnamurty et. al. (1984) use it to describe sectoral gross value added where as the Planning Commission in the Technical Note uses it for sectoral output including gross value added, material inputs and indirect taxes less subsidies related to production sector. Following the latter meaning of the term, we have defined it as the total value of purchases of material inputs and services plus that of primary inputs and indirect taxes less subsidies, which also equals total sales of output to other sectors as their input plus sales for consumption, gross domestic capital formation and exports minus imports.

The data for gross output is straightaway available in the NSA, at both current and constant prices for our Agriculture, Forestry and Logging, Fishing, Mining and Quarrying and Construction Sectors. For Railways and Communications, gross earnings have been considered as gross value of output because they can be treated as...
money value of services sold to various buyers. Of course, at least for Railways it may be an underestimate of the services provided to the economy because of loss of earnings due to ticketless travel. In the case of Real Estate and Ownership of Dwellings, gross rental value of Dwellings plus value of Business Services provided are considered as gross output of the sector. This again may be an underestimate of the actual residential services provided by the sector due to unaccounted component of "Pugree" and under statement of rents on the part of owners of real estate and dwellings to minimise payments of income and house tax, etc.

For the remaining six sectors, the gross output figures have been obtained as follows:

Manufacturing: The data for Manufacturing sector are published separately for registered and unregistered categories in the NAS. Gross output figures, are however available at current prices for registered sectors only. To obtain data for unregistered category, the ratio of gross output to gross value added has been computed for each year from the registered category. Assuming that the ratios hold for unregistered category, an estimate for gross output has been worked out by multiplying the annual gross value added of the unregistered sector by the ratio of the registered sector, for corresponding years. These estimates of gross output are added to the
gross output of registered sector to get the total value of gross output of the Manufacturing sector. The estimates are then deflated by the wholesale price index for Manufacturing for obtaining the estimates of gross output at constant 1970-71 prices. Index number of wholesale prices have been computed as weighted average of wholesale price indices for Manufactures, Machinery and Transport equipment, Chemicals, Kerosene Oil and Petrol, using 1970-71 weights. The information regarding these indices and weights comes from the RCF.

Electricity, Gas and Water Supply; Other Transport; Trade, Hostels and Restuarant; Banking and Insurance; and Services:

For these five sectors, the value of gross output is not available, we have therefore no alternative to making a crude estimate of the value of gross output. For this purpose, we have worked out the ratios of gross output to gross value added for each of these sectors from the matched transaction table based on the Planning Commission table. The sectoral gross value added figures, which are available for each of these sectors are multiplied by their respective gross output to gross value added ratio to get an estimate of sectoral gross output. Validity of such an estimation is questionable, however, since the final model satisfactorily replicates the behaviour of the

25. See subsection on adjustment of matrix (3.3.3).
economy for the sample period, we may accept such an approximation of sectoral gross output.

To obtain the values of these sectoral gross outputs, we have deflated them by the implicit price deflators for their sectoral gross value added, except for Electricity, Gas and Water Supply, whose gross output is deflated by the price index for electricity obtained from the RCF. Since electricity covers more than 93 percent of the sectoral activity, its prices are expected to dominate the prices of the sectoral output and hence we may use this deflator for the purpose. We have to settle for these deflators due to paucity of data.

(ii) **Gross Value Added (GVA)**: The data for gross value added for the sectors included in the present study are directly available at both current and constant (1970-71) prices in the NAP except for Manufacturing sector. In case of Manufacturing sector, the gross value added data have been obtained by adding corresponding annual figures for registered and unregistered categories. For Services it has been found by adding Other Services and Public Administration and Defence Services.

(iii) **Total Gross Domestic Capital Formation (DGCF)**: Information regarding total gross domestic capital formation is available at sectoral level at both current and constant 1970-71 prices. This data pertains to the sector in which capital formation is taking place i.e. sector of use. The word "total" implies total of private
and public gross domestic capital formation in that particular sector. The figures are straight-away available for all sectors except Services, for which they have been obtained by adding the figures for Other Services and Public Administration and Defence Services.

(iv) **Gross Domestic Capital Formation in the Public Sector (DKFG):**

These data are directly available in the NAS for all the sectors except for services for which we have to aggregate the figures for Other Services and Public Administration and Defence Services. The data published are at current prices as well as at constant (1970-71) prices.

(v) **Gross Domestic Capital Formation in the Private Sector (DKFP):**

The data on Gross Domestic Capital Formation in the private sector are not available directly at sectoral level in the NAS. We have calculated it as the difference between the 'Total' and the 'Public sector' gross domestic capital formation for each sector and for each year, at both current and constant (1970-71) prices.

(vi) **Sectoral Gross Output Prices-The Price Deflators for Gross Output (DVOPF):**

The implicit price deflators for gross outputs have been worked out by dividing gross outputs at current prices

26. The terms "Public" and "Government" have interchangably used in the text and pertain to "Public". For example, Public Consumption and Government consumption refer to same variable.
by their respective values at constant (1970-71) prices. These implicit deflators have been considered as prices for sectoral gross outputs. Implicit price deflators have been preferred to wholesale price indices for two reasons: One, they avoid fixed weighting mechanism up to some extent, and two, matching wholesale price indices are not available from our sectoral classification point of view. However, it should be pointed out that for six sectors, the implicit price deflators so obtained may not be the true implicit deflators. For Manufacturing and 'Electricity, Gas and Water Supply', the deflators will be the index numbers of wholesale prices for Manufacturing and Electricity, respectively, and for Banking and Insurance, 'Other Transport and Storage', 'Trade Hotels and Restaurants' and Services, they will be the implicit price deflators for the sectoral gross value added.

It is worth mention at this stage that the two deflators, viz., the implicit price deflator for gross output and the implicit price deflator for gross value added, are different variables. We have used the latter for four sectors because of paucity of data. However, the difference between the two remains - the latter reflecting more on the prices of primary inputs and the former incorporating the influence of rise in prices of gross output due to rise in raw material prices. Thus, the former is more suitable for deflating the gross output whereas the latter is more appropriate for deflating sectoral income.
The implicit price deflator for gross value added can be used to deflate gross output under the rigid assumption that the primary input prices are instantaneously adjusted proportionately to change in prices of gross output which itself is being caused by change in material input prices. Thus, our deflation for gross value added is subject to this assumption. However, in case of 'Trade, Hotels and Restaurant' and 'Banking and Insurance', the two deflators, viz., gross output and gross value added, may be close enough because the material input content in these two sectors is relatively small as compared to gross value added (about 3% and 15% respectively). But, in case of Other 'Transport and Storage' and Services the material inputs consist of about 40-45 per cent of the gross output. Thus, our estimates of gross output at 1970-71 prices for these sector may be over-estimated.

(vii) **Prices of Primary Inputs - The Sectoral Gross Value Added Deflators (DGVAR):**

These have been worked out from the data available in the NAS for sectoral gross value added at current and constant (1970-71) prices by dividing the former by the latter.

(viii) **Prices of Investment - The Implicit Price Deflators for Gross Domestic Capital Formation:**

The data for this variable have been seperately computed for the total, public sector and private sector gross domestic capital formation i.e. DKPT., DKFG., DKFP., for each production sector. The method is same as that
for gross value added, that is, value at current prices divided by the value at constant (1970-71) prices. These deflators are again based on data from the NSA.

(ix) **Price of Indirect Taxes Less Subsidies**: Data regarding Indirect Taxes Less Subsidies are not available in the NAS at sectoral level. However, we have obtained estimates of Indirect Taxes Less Subsidies at sectoral levels for the production sectors as well as for the components of final demand.

The Indirect Taxes Less Subsidies were expected to account for not more than 5% of the sectoral totals because they constitute about 8-10 per cent of the GDP at current market prices for the economy as a whole. Thus, attempt has not been made to estimate deflators for these at sectoral levels and a single deflator has been considered valid for each sector.  

27. The formula used for obtaining price deflator for Indirect Taxes Less Subsidies is as under:

\[
P = \frac{T \cdot P_1 \cdot P_2}{P_2 \cdot Y_1 - P_1 \cdot Y_2}
\]

where \( P \) is the unknown price deflator for Indirect Taxes Less Subsidies and \( T, Y_1, Y_2, P_1 \) and \( P_2 \) are Indirect Taxes Less Subsidies at current prices, GDP at current market prices, GDP (factor cost) at current prices, price deflator for \( Y_1 \) and price deflator for \( Y_2 \), respectively.
(x) Sectoral Employment and Labour - Output Ratios: The data on employment in the Indian economy is quite scanty. Though, a large number of organisations are compiling employment data, it is quite difficult to construct on the basis of available data, a time series comparable to the NAS sector classification from the published data.

The definition of employment also varies from source to source. For example, the Labour Bureau publishes average daily employment, the National Sample Survey (NSS) defines it on the bases of 'status code', the 'Directorate General of Employment and Training' (DGET) and the Annual Survey of Industries (ASI) usually present it as 'persons'. The Census of India provides decennial figures of 'workers' which are not comparable over time due to change in the definition of 'workers'. Further, the Labour and the Directorate General of Employment and Training confine their definition of employment to the registered sector.

The employment data suffers from various limitations. We shall confine our description to the limitations of employment data available from two major sources, viz. the NSS and the Employment Market Information (DGET).

---

27. Including the Labour and the Directorate General of Employment and Training, the National Sample Survey Organisation, the Annual Survey of Industries, etc.

28. For example, the definition of 'workers' is not the same for 1961 and 1971 Census.
"No current data on total employment are at present available. The information on persons employed collected in various round of the NSS have also not been found satisfactory for estimating the size and rate of working force. This is mainly because such surveys are not carried out at regular intervals and the results are affected between rounds due to differing reference periods, and changes in the concept of employment adopted in different rounds.

The other source of current data, viz., Employment Market Information (DGET) have partial coverage because of exclusion of self employed and establishments in the private sector employing less than 10 workers, enterprises in defence and unorganised sectors." 29

The ASI covers only the manufacturing industries and, thus, provide data only for part of our sector classification.

After due scrutiny of the data on employment from various sources, it was found that none of these can straightaway be used for our purpose because of comparability and coverage problems, and hence, we consider the employment estimates for 1979-80, published by the Planning Commission (1981a). 30 These estimates of sectoral employment are in


30. Detailed methodology and sources of data are given in the Technical Note, Planning Commission (1981), pp.43-50. While presenting (pp.208) the employment estimates for 'Agriculture', 'Forestry and Logging' and 'Fishing', sectors have been aggregated without giving any reason. It seems that the aggregation has been done to absorb f.n. contd..
Million Standard Person Years (MSPY), Standard Person Year being defined as 8 hours of work per day for 273 days.

The estimates of employment in MSPY for 1979-80 for each sector have been divided by its respective gross output for 1979-80 in million rupees at constant (1970-71) prices in order to obtain our estimates of labour-output ratios. Since these ratios have very small magnitude, we multiply them by $10^6$ and thereby make their unit as Standard Person Years per million rupees of gross output at 1970-71 prices. These labour-output ratios are assumed to be constant for the period 1976-77 to 1981-82 and have been used for estimating sectoral direct, indirect and total employment in the economy, with the help of our estimated series of input-output tables and observed values of components of the final demand at (1970-71) prices.\(^{31}\)

3.3.3. Input-Output Tables: For the purpose of constructing our model, we require input-output table which has sector classification that matches with our sector classification. In other words, the input-output tables

\[\text{the abnormally large value of estimated employment elasticity (27.95968) for the Forestry and Logging sector. However, in Planning Commission (1981a), these estimates are available for 14 sectors (p.7).}\]

31. For details of methodology for estimating direct, indirect and total employment, see Chapter 4, (The Input-Output Block of the Model, 4.1.8).
must correspond to the sector classification of the NAS. The 14-sector table presented by Planning Commission in the Technical Note has a similar classification except for four sectors. The following steps have been taken to bring the Planning Commission matrix as close as possible to the NAS classification. The matrix for 1979-80 at 1979-80 prices has been considered for this purpose. First of all the commodity by industry matrix is converted to industry by industry matrix by pre-multiplying it with the make-matrix. This, of course, implies that the inputs are purchased by sectors of production in the same proportion in which they are produced by the producing industry. Such a conversion does not substantially change the non-zero cells of the matrix because the make matrix shows that only three sectors are producing commodities of other sectors, viz. Agriculture, Manufacturing and Services, and these are very small in magnitudes when compared to total commodity output. (For example, the Manufacturing sector produces only Rs.123 worth of agricultural commodity output in a total of one million rupees and the agriculture produces the major chunk, i.e. Rs.999877. Similarly, the manufactured commodity output worth one million rupees has just Rs.972 produced by Agriculture and Rs.148 produced by Services sector, rest of the output is produced by the Manufacturing sector itself). This conversion, however, changes certain zero cells of the commodity by industry matrix into non-zero,
such cells may, however, be ignored because their magnitude is not more than ₹15 per million rupees of total inputs purchased by the sector. Moreover, we do not expect such cells to influence much, the Leontief Inverse of the matrix.

Once we have converted the table into an industry by industry table, we make certain adjustments for matching it to the NAS sector classification. These adjustments can be better explained with the help of table 3.2. Since only 4 sectors require matching, we present them in this table.

**Table 3.2**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Planning Commission classification in the Technical Note</th>
<th>Our and NAS classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Other Transport</td>
<td>Other Transport and Storage</td>
</tr>
<tr>
<td>11</td>
<td>Trade, Storage and Warehousing</td>
<td>Trade, Hotels and Restaurants</td>
</tr>
<tr>
<td>13</td>
<td>Real Estate and Ownership of Dwellings</td>
<td>Real Estate and Ownership of Dwellings and Business Services</td>
</tr>
<tr>
<td>14</td>
<td>Public Administration, Defence and Other Service (including services provided by Hotels and Restaurants etc., and Business Service)</td>
<td>Public Administration, Defence and Other Services</td>
</tr>
</tbody>
</table>

32. Such cells are bound to appear in the industry by industry tables if they are obtained from commodity by industry or industry by commodity tables. In our case all sectors taking inputs from manufacturing will have very small non-zero cells for the row for Agriculture and Services, even if they do not purchase any inputs from these sectors, similarly row for Manufacturing sector will have non-zero cells with very small magnitude for the sectors which are not purchasing inputs from Manufacturing sector, but are purchasing inputs either from Agriculture or from Service or from both.
The adjustment are made on the basis of gross value added figures at current prices for 1979-80, which are separately available in the NAS for Other Transport, Storage, Trade, 'Hotels and Restuarant', 'Real Estate and Ownership of Dwellings', Business Services, and Services. These figures are added for 'Trade and Storage', and for Services rendered by 'Hotels and Restuarants' and 'Business Services'. The proportion of Trade in the total for Trade and Storage is worked out. Similarly, proportion of Storage in total for Trade and Storage is calculated. These proportions are applied to the row and column corresponding to the sector, i.e., the 11th row and 11th column, in the industry by industry table to obtain estimates of Trade and Storage, separately. Similarly, the row and column corresponding to services, i.e., the 14th row & 14th column, are split into Hotels and Restuarants, Business Services and rest of the Services. Now, the proper rows and columns are aggregated to obtain a matrix which corresponds to our classification. This adjustment is subject to assumption that sectors take inputs and give output in proportion of gross value added of various industries in that sector.

It should be noted that only gross and net value added figures are available for these components of the sectors in the NAS.
### Fig. 3.1

**MASTER TRANSACTION TABLE**

<table>
<thead>
<tr>
<th></th>
<th>A (14x14)</th>
<th>C</th>
<th>G</th>
<th>K (14x14)</th>
<th>S</th>
<th>E</th>
<th>X'</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>TC</td>
<td>TG</td>
<td>TK</td>
<td></td>
<td>O</td>
<td>TE</td>
<td>T'</td>
</tr>
<tr>
<td>B</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>(14x14)</td>
<td>O</td>
<td>O</td>
<td>V'</td>
</tr>
<tr>
<td>MO</td>
<td>CMO</td>
<td>GMO</td>
<td>O</td>
<td></td>
<td>O</td>
<td>O</td>
<td>MO</td>
</tr>
<tr>
<td>MG</td>
<td>CMG</td>
<td>GMG</td>
<td>KM</td>
<td></td>
<td>O</td>
<td>O</td>
<td>MG</td>
</tr>
<tr>
<td>O</td>
<td>O</td>
<td>O</td>
<td>Q</td>
<td>(14x14)</td>
<td>O</td>
<td>O</td>
<td>Q</td>
</tr>
<tr>
<td>X'</td>
<td>ĉ</td>
<td>Ġ</td>
<td>İ</td>
<td>(14x14)</td>
<td>S</td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>
The matrix so obtained, however, does not fully tally with the information provided in the NAS for two reasons: one, and the more important one, that the matrix has been prepared by the Planning Commission using "quick estimates" for 1979-80, whereas we are using the finalised data for 1979-80, and two, we have tried to match the sectors to NAS classification by probata adjustment for four sectors of the matrix.

For our purpose, we need some further adjustments in the matrix as we need a matrix at constant (1970-71) prices and of the type shown in figure 3.1. We call it Master Transaction Matrix. This matrix has 33 rows and 33 columns as described, below:

\[
A = (A_{ij}) \quad \text{is a matrix of the order } 14 \times 14 \text{ where } A_{ij} \text{ show the deliveries of the output by sector } i \text{ to sector } j \text{ for being used as input by sector } j.
\]

\[
C = (C_i) \quad \text{is the private final consumption vector of the order } 14 \text{ in which } C_i \text{ is the delivery of output by sector } i \text{ for private consumption.}
\]

\[
G = (G_i) \quad \text{is the government consumption vector of the order } 14, \text{ where } G_i \text{ is the delivery of output by sector } i \text{ for government consumption.}
\]

34. Output of goods and services in monetary units.
\[ \mathbf{K} = (K_{ij}) \]

is a 14 x 14 matrix showing composition of gross domestic fixed capital formation from the sector where it is originating to the sector where it will be used. Thus, \( K_{ij} \) shows value of deliveries of investment goods from sector \( i \) to sector \( j \).

\[ \mathbf{S} = (S_i) \]

is a vector of the order 14 showing changes in stocks by industry of origin. The elements \( S_i \) represents output of sector \( i \) for the purpose of net inventory building.

\[ \mathbf{E} = (E_i) \]

is a vector of exports of the order 14 where \( E_i \) is the output of sector \( i \) being exported.

\[ \mathbf{\bar{X}} = (\bar{X}_i) \]

is Gross Output vector of the order 14 where \( \bar{X}_i \) shows the total production of the gross output by sector \( i \).

We may write \( \bar{X}_i \) as,

\[ \bar{X}_i = \sum_{j=1}^{14} A_{ij} + C_i + G_i + \sum_{j=1}^{14} K_{ij} + S_i + E_i \text{ for } i = 1, 14 \]

\[ \mathbf{T} = (T_j) \]

is a vector of Indirect Taxes less Subsidies for each sector. Thus, \( T_j \) are the Indirect taxes net of Subsidies for sector \( j \).

\( \mathbf{TC}, \mathbf{TG}, \mathbf{TE} \)

are Indirect Taxes less Subsidies on Private Consumption, Government Consumption and Exports.

\[ \mathbf{TK} = (TK_j) \]

is a Vector of Indirect Taxes less Subsidies of the order 14 having elements \( TK_j \), the Indirect Taxes net of subsidies on the total purchases of investment goods by sector \( j \).

\[ \mathbf{T} = \]

Total Indirect Taxes less Subsidies.
B = \((B_{ij})\) is a 14 x 14 diagonal matrix having sectoral gross value added in its principal diagonal, thus,

\[ B_{ij} = \text{gross value added at factor cost in sector } j \text{ for } i = j \text{ and } B_{ij} = 0 \text{ for } i \neq j. \]

\[ V = (V_i) \] is a Vector of the order 14 such that \( V_i \) is the gross value added in sector \( i \neq t \).

Also, \( B_{ij} = V_i \) for \( i = j \) and \( B_{ij} = 0 \) for \( i \neq j \).

\[ MO = (MO_j) \] is a Vector of the order 14 in which \( MO_j \) is the Oil Imports by sector \( j \) for production purposes (as inputs).

\[ MG = (MG_j) \] is a Vector of Imports other than Oil, where \( MG_j \) are such imports by sector \( j \) for production activity (as inputs).

\[ KM = (KM_j) \] is a Vector of Imports of the order 14 for investment purposes. Elements \( KM_j \) represent imports for investment purposes by sector \( j \).

CMO, GMO and \( MO \) are Oil Imports for Private Consumption, Government Consumptions and total Imports of Oils respectively.

CM, GM and \( MG \) are Imports other than Oil for Private Consumption, Government Consumption and total Imports other than Oil, respectively.

\[ Q = (Q_j) \] is a Vector of changes in stocks by sector of use. Thus \( Q_j \) represents changes in stocks in sector \( j \). It should be noted that \( Q \neq S \). However,

\[ \sum_{i=1}^{14} Q_j = \sum_{i=1}^{14} S_i = \bar{Q} = \bar{S} \]
These are total Changes in Stocks in the economy.

\( \bar{X} = (x_j) \) is a gross input vector of the order 14. Elements of this vector \( x_j \) are the gross inputs taken by sector \( j \). Since total outputs delivered by a sector should be equal to total inputs taken by the sector, this vector is nothing but transpose of \( \bar{X} \) vector.

\( \bar{I} = (i_j) \) is a vector of the order of 14 showing gross domestic capital formation (at market prices) taking place in the sector. Thus, \( i_j \) means gross domestic capital formation in sector \( j \).

\( \bar{C}, \bar{G}, \bar{S} \) and \( \bar{E} \) are total private consumption, total government consumption, total changes in stocks (all at market prices) and total exports, respectively.

0 represents a zero, a null vector or a null matrix depending on the place where it is positioned.

3.3.3.1. Adjustments for Obtaining the Master Transaction Matrix:

The Planning Commission has published an import transaction matrix for 1979-80 c.i.f. prices. The matrix is as per the Planning Commission classification of sectors which we have changed to match the MAE classification. Out of fourteen sectors in both the classifications, ten have perfect matching. In the rest of the four sectors, we have made changes whose relative magnitudes are small. Details of these adjustment have been mentioned in 3.3.3. Here we
shall only summarise them. Storage has been taken out from the 11th sector of the Planning Commission and added to the 9th sector. Hotels and Restaurants have been taken out from the 14th sector and added to the 11th sector, similarly Business Services have also been taken out from 14th sector and added to the 13th sector. Ideally, we should also do a similar matching for the import transaction matrix. But it is not possible to do so due to paucity of suitable data regarding imports by sector of use at disaggregated level. Therefore, we assume that the import transaction matrix matches, by and large our classification. This assumption may be justified on the grounds that since the components which are being subtracted from one sector and being added to the other have quite small relative magnitudes and consequently much smaller import contents (Business Services are not expected to have any import content). Thus, our slight change in the sector classification may have negligible or even no influence on the import transaction matrix.

It may be mentioned here that the Planning Commission has not been able to build any concept of competitive and non-competitive imports in the Technical Note and we also follow suit.

As our first adjustment, the imports are netted out from our transaction matrix obtained after matching the sectors with the M^S classification. (This netting eliminates the imports column from the original transaction
matrix). After netting out the imports from the intermediate use portion of the Planning Commission matrix adjusted by make matrix, we get partition A of our Master Transaction Matrix.

The imports are then introduced as rows of Oil Imports and Imports other than Oil. For this purpose we resort to the disaggregated import transaction matrix of the Planning Commission consisting of 89 sectors for the same year and at same prices. In the 89-sector matrix, we can identify the sectors related to Oil Imports, i.e., Sectors 17, 43 and 44, these are Petroleum and Natural Gas, Petroleum Products and Miscellaneous Coal and Petroleum Products. These three rows are aggregated and then again aggregated by columns, to get a row matching with the fourteen sector import transaction table. It should be noted that sectors 43 and 44 are part of sector 4 in the intersectoral transaction matrix but from the imports point of view we have added them to Oil Imports. Such an addition appears to be perfectly reasonable as we are interested to separate imports of Oil based products. It should, however, be pointed out that imports of fertilisers are not included in the imports of oil based products.

35. Aggregating columns 1 to 15 of the 89 x 89 table gives us column 1 of the 14 sector table, columns 16 to 19 give 4th sector, columns 20 to 78 excluding 43 and 44 give sector 5 and columns 87 to 89 give sector 14. Columns 14, 15, 79, 80, 81, 82, 83, 84, 85, and 86 straight away give sectors 3, 4, 6, 7, 8, 9, 10, 11, 12 and 13.
Once we have the row for Oil Imports, we can work out Imports other than Oil by subtracting it from the column totals of the import transaction matrix. These become partitions MO and MG, respectively, in our Master Transaction Matrix.

The Planning Commission has published a matrix for converting the investment by destination into investment by source (i.e. by industry of origin). This has been entitled the Capital Coefficient Matrix for 1979-80. The matrix gives the break-up of one unit worth of investment in a sector into that going in for Construction, Purchase of Machinery and Equipment and for building inventories (Changes in Stocks).

A glance at the transaction table presented by the Planning Commission for the same year reveals that for gross fixed capital formation, inputs are being purchased from 'Agriculture (0.7), Manufacturing (27.0), Construction (47.6), 'Railways (0.1), 'Other Transport' (0.9) and 'Trade, Storage and Warehousing' (7.3). It is not clear in the capital coefficient matrix that where the Planning Commission has classified the deliveries of these investment goods except those which are going from Construction and Manufacturing. However, the sectors other than Manufacturing and Construction constitute only

36. The figures in brackets are percentage share of the deliveries of sector's output for investment purposes in total gross investment in the economy.
about 9% of the total gross investment according to the Technical Note. This encourages us to disaggregate the 14 x 3 capital coefficient matrix given by the Planning Commission in the Technical Note into a 14 x 6 matrix, by making some heroic assumptions.

(a) The deliveries of investments goods from Animal Husbandry which is included in our Agricultural Sector constitute about 0.7 percent of the gross investment in the economy. The destinations, i.e., sector of use, of these goods are not evident from the information presented in the Technical Note. However, there is a common sense appeal that these investment goods can only be draught cattle and, thus, their destination can be mainly the Agricultural sector itself and Other Transport sector (primarily the bullock carts). Here we assume, somewhat arbitrarily, that 70 per cent of these deliveries are made to the Agricultural sector and 30 per cent to Other Transport. Since the total shares of these deliveries in the gross investment in the economy is very small (only 0.7%), it would not make much of difference whether we consider its break-up as 70:30 or 60:40 or 40:60. However, 70:30 appeared reasonable to us because Agriculture is expected to use more of animate draught power than Other Transport. Further, since these deliveries are shown as gross fixed investment in the transaction matrix presented in the Technical Note, they cannot be classified as part of Construction in the capital coefficient matrix. We conclude
therefore, that these deliveries of investment goods from Agricultural sector would be classified with machinery and equipment in the capital coefficient matrix.

(b) Deliveries of investment goods from Railways, Other Transport and Trade constitute about 8.4% of total gross investment in the economy. We assume that these deliveries are distributed according to the percentage distribution of gross fixed investment across the sectors of use and are classified along with machinery and equipment. Again, since the total contribution of these components is small, it is not expected to significantly alter the capital coefficient matrix.

Now we proceed to construct our K-matrix and the vector, which are partitions of our Master Transaction Matrix. We have first multiplied each row of the capital coefficient matrix by the figures of sectoral total investments by destination for 1979-80 available in the Technical Note. This operation gives us a matrix which shows investment by origin and destination. The third column of this matrix gives us changes in stocks by sectors of use and its transpose become the partition Q of our Master Transaction Matrix. Remaining two columns of the investment break-up are made 5th and 6th rows of our K-matrix such that 1st column of the investment break-up matrix becomes 6th row of the K-matrix and 2nd becomes the 5th row. Value of deliveries of investment goods from Agriculture (Animal Husbandry) are split and
70 per cent of this is placed in the 1st column of 1st row (the row and column corresponding to agricultural sector) and 30 per cent in the 9th column (Other Transport) in the same row. The value of deliveries of investment goods from Railways, Other Transport and Trade are broken-up in proportion to gross fixed investment across the sectors of use and placed in the row against each of these sectors, i.e. 8th, 9th and 11th row. All other elements in the matrix are zero. Columnwise totals of row 1, 8, 9 and 11 are subtracted from the 5th row so that total fixed investment in each sector of use is not altered. The indirect taxes given in the Technical Note transaction matrix, which constitute about 5 per cent of the total gross investment, are distributed over sectors of use according to percentage distribution of gross fixed capital formation across these sectors. This become partition TK of our Master Transaction Matrix. Imports for gross fixed investment given in the import transaction matrix for 1979-80 in the Technical Note which constitute about 3.7 per cent of the total gross investment, are also distributed adopting a method similar to that adopted for obtaining TK. This break-up of imports makes our partition KM of the Master Transaction Matrix. Since the imports for gross fixed investment are of only the manufactured items as per import transaction matrix of the Technical Note, we substract row KM (partition) from the fifth row of the K-matrix. This makes our K matrix net of imported.
investment goods. In other words, K-matrix now gives us the flow of domestically produced investment goods from sector of origin to the sector of use. It should be noted that the import transaction matrix shows no imports except those of manufactured items for gross fixed investment purposes. Absence of Changes in Stocks column from the Import Transaction Matrix in the Technical Note suggests that there are no or negligible imports for the purpose of building inventories, or possibly these inventories are held at constant level such that there are no Changes in Stocks from year to year. The former of these reasons appear to be more appropriate than the latter.

Private and Government Consumption columns in the import transaction matrix show imports for these purposes. These have been disaggregated into CMO and CMG for Private Consumption and also GMO and GMG for Government Consumption. The method adopted for this purpose is the same as one adopted to break the imports into MD and MG for the production sectors, i.e., for obtaining MO and MG of our transaction matrix. This method makes use of the disaggregate import transaction matrix consisting of 89 sectors which are available for the same year in the Technical Note. CMO and CMG for Private Consumption and GMO and GMG for Government Consumption become cells CMO, CMG, GMO, GMG, respectively, in our Master Transaction Matrix.
The TC, TG and TE are straightaway available in the transaction matrix in the Technical Note. They are, respectively, the Indirect Tax on Private Consumption, Government Consumption and Exports, respectively.

Sectoral gross value added given in the Technical Note as row 17 of the transaction matrix is converted into a diagonal matrix and placed as matrix B which is one of the partition of our master transaction matrix. Mathematically, we may say that the row for sectoral gross value added is post-multiplied by an identify matrix of suitable order to obtain our B matrix.

Partitions C, G, S and E in our Master Transaction Matrix are columns for Private Consumption, Government Consumption, Changes in Stocks by sectors of Origin and Exports given in the transaction matrix of the Technical Note.

Now we have obtained our Master Transaction Matrix at 1979-80 prices and it is ready for further adjustments.

As mentioned earlier the totals of the transaction matrix given by Planning Commission in the Technical Note differ from those presented in the NAS for the same year at same prices. For our purpose, these totals should match at constant (70-71) Prices. Thus, further adjustments are required in our Master Transaction Matrix. These adjustments are as follows.
First, we have deflated each row of the Master Transaction Matrix using a suitable deflator at base 1970-71 = 1.0, worked out from the NAS. Deflators for the row for Oil imports and Imports other than Oil are, however, obtained from the RCF as mentioned earlier. Thus, first fourteen rows are deflated using corresponding implicit price deflators for gross output, fifteenth row is divided by implicit price deflator for indirect taxes less subsidies, sixteenth through twenty-ninth rows are deflated with the help of corresponding implicit price deflators for sectoral gross value added thirtieth and thirty-first rows are deflated by UVI for Oil imports and imports other than Oil respectively, and the thirty-second row is divided by the implicit price deflator for total changes in stocks.

Mathematically,
\[ \tilde{Z} = P^{-1} Z \]

where \( Z \) and \( \tilde{Z} \) are our Master Transaction Matrices at current and constant prices respectively and \( P \) is a diagonal matrix with value of deflators for 1979-80 (at base, 1970-71 = 1.0) in its principal diagonal, corresponding to rows of the \( Z \)-matrix.

The conversion of \( Z \) to \( \tilde{Z} \) disturbs slightly the row and column totals and almost all the totals which were earlier consistent with each other become different. For example, \( \tilde{Q} \) and \( \tilde{S} \) which were earlier equal, remain
no more equal. Similarly, total sectoral gross inputs become different than total sectoral gross outputs. This is bound to happen if the deflators are not perfectly consistent with each other and we cannot expect our deflators to be perfectly consistent as they have been estimated from the data from different sources. However, the difference between the total gross input and the total gross output for the same sector is not more than ± 3 per cent for any sector in our $Z$ matrix.

3.3.3.2. **RAS Adjustment:**

The matrix $Z$ is subjected to RAS adjustment, as mentioned above, for two reasons: (a) inconsistency between various row and column totals of $Z$, and (b) non-matching of the row and column totals of the $Z$ matrix with their corresponding figures available in the NAS. Here we would briefly describe the RAS method.

**The RAS Method:**

The RAS method is being frequently used for adjusting and updating input-output tables since late fifties in almost all the countries which are using these tables for their planning and/or research activities. It has also been used for adjusting and updating occupation industry matrices. (Gaiha 1973, Alam 1983). The Planning Commission uses the RAS method to adjust and update input-output tables for India. Consumption break-up tables have also been adjusted with the help of this
method (e.g., in Technical Note, Mohammad 1978).

Although this method is being extensively used in economic planning and research throughout the world, the method does not appear to be based on sound economic theory and reasoning. It is only a mechanical method. However, its validity and reliability for adjusting/updating input-output tables are widely accepted as is evident from its extensive use in economic literature.

To check the performance of the RAS method, Paelinck and Waelbroeck (1965) carried out an exercise using data for the Belgian Economy. This exercise has become popular in the economic literature with the name "The Belgian Tests".

The Belgian Tests were carried out by using two directly observed input-output matrices for 1953 and 1959 for the Belgian economy, each having comparable 21-sector classification and 270 non-zero cells. Control totals were obtained from 1959 matrix and the 1953 matrix was updated by using these control totals. The updated matrix was compared with the observed matrix for 1959. Out of 270 non-zero cells, 250 showed either no difference or differences of less than 0.5 per cent, 11 non-zero cells had differences between 0.5 and 1.0 per cent, and 9 had more than 1 per cent difference. The

37. For meaning of these terms see, details of the RAS method.
test was repeated with modified RAS method in which six badly estimated cells were removed from the table and from the corresponding control totals. These cells were exogenously obtained and put back in the table. This table when compared with the observed table for 1959 showed improvement in the estimates, as 262 out of 270 non-zero cells had errors less than half a per cent, 7 had errors between one-half and one per cent and only one cell had a difference greater than one per cent.

In the light of Belgian tests and its extensive and intensive use throughout the world, we accept the RAS method as a reliable and helpful tool and use it for our adjustments.

Mathematical formulation of the RAS method

In this sub-section, we have briefly described the algebra of the RAS method. The method will be mentioned for a rectangular matrix.

Let $A^0$ be a known matrix of the order $m \times n$ and $A^*$ as an unknown $m \times n$ matrix whose row and column totals are known and are identified by vectors $U$ and $V$ of the order $m$ and $n$, respectively. Thus, if we denote elements of $A^*$, $U$ and $V$ by $a^*_{ij}$, $u_i$ and $v_j$, respectively, we have,

$$\sum_{j=1}^{n} a^*_{ij} = u_i \quad \text{for} \quad i = 1, 2, \ldots, m$$

38. $U$ and $V$ are often referred to as row control totals and column control totals.
\[ \sum_{i=1}^{m} a_{ij}^* v_j = u_i \text{ for } i = 1, 2, \ldots, n \]

and

where \( a_{ij}^* \) are unknowns, \( u_i \) and \( v_j \) are known values.

We assume, that each row of \( A^0 \) is subjected to a change, and similarly each column is also subjected to a change, such that both these changes given us matrix \( A^* \). This may be expressed mathematically by denoting these changes by \( r \) and \( s \) diagonal matrices, respectively, where \( r \) is of the order \( m \) and \( s \) that of \( n \). These are termed as row multipliers (\( r \)) and column multipliers (\( s \)). Now, we have.

\[ A^* = r A^0 s \]

or \( a_{ij}^* = r_{ii} a_{ij}^0 s_{jj} \) for \( i = 1, 2, \ldots, m \) and \( j = 1, 2, \ldots, n \)

where \( a_{ij}^* \), \( r_{ii} \) and \( s_{jj} \) denotes elements of \( A^0 \), \( r \) and \( s \), respectively.

Our problem is to find \( r \) and \( s \), such that

\[ \sum_{j=1}^{n} r_{ii} a_{ij}^0 s_{jj} = u_i \text{ for all } i = 1, 2, \ldots, m \]

and

\[ \sum_{i=1}^{m} r_{ii} a_{ij}^0 = v_j \text{ for all } j = 1, 2, \ldots, n \]

Thus, in other words, our problem is to solve a system of \((m + n)\) equations with \((m + n)\) unknowns in which the unknown \( r_{ii} \)'s and \( s_{jj} \)'s appear in multiplicative form. The system may be solved in more than one ways and we may have more than one solution to this system.
of equations, each solution leading to the same $A^*$ matrix. However, an iterative method is preferred by economists because the value of $r$ and $s$ obtained through this method have economic interpretation. The iterations are performed as per following steps.\textsuperscript{39}

(i) Find \[ \sum_{j=1}^{n} a_{ij}^{0} = u_{i}^{1} \] for $i = 1, 2, \ldots, m$

(ii) Find \[ r_{i}^{1} = \frac{u_{i}^{1}}{u_{i}^{0}} \] for all $i = 1, 2, \ldots, m$

(iii) Compute $A_{i}^{1} = (a_{ij}^{1})$ such that

\[ a_{ij}^{1} = r_{i}^{1} a_{ij}^{0} \] for all $i = 1, 2, \ldots, m$ and $j = 1, 2, \ldots, n$

Thus we obtain a matrix $A_{i}^{1}$ for which

\[ \sum_{j=1}^{n} a_{ij}^{1} = u_{i} \] for all $i = 1, 2, \ldots, m$

We have obtained a matrix for which row totals are equal to the given row totals of unknown $A^*$ matrix, but the column totals may or may not match the given column totals of $A^*$. Thus, we proceed further

(iv) Find \[ \sum_{i=1}^{m} a_{ij}^{1} = v_{j}^{1} \] for $j = 1, 2, \ldots, n$

(v) Find \[ s_{j}^{1} = \frac{v_{j}^{1}}{v_{j}^{0}} \] for $j = 1, 2, \ldots, n$

(vi) Compute $A_{i}^{2} = (a_{ij}^{2})$ such that

\[ a_{ij}^{2} = a_{ij}^{1} s_{j}^{1} \] for all $i = 1, 2, \ldots, m$; $j = 1, 2, \ldots, n$

\textsuperscript{39} The superscript denotes the iteration number and should not be confused with the "power". For example, $A_{i}^{2}$ stands for $A^*$ after 1st iteration and not $A$ raised to the power 2'.
This operation (steps iv to vi) generates a matrix $A^2$ which satisfy the column totals $v_j$'s of the unknown matrix $A^*$, but obviously disturbs the matching of the row totals obtained by performing steps (i) to (iii). Thus, steps (i) to (vi) are performed repeatedly, each time the three steps performed to match one set of totals, disturb the other set. However, this disturbance has a dampening tendency and a stage is reached when the cells of the matrix get stabilised and further repetition of steps (i) to (vi) does not disturb the matching of the two sets of totals. Suppose such a stage is reached after repeating steps (i) to (vi) for $k$ times, then we would say in mathematical terminology that the system has converged or the convergence has been obtained after $k$ iterations. The cells of the matrix can be considered as stabilised in $k$ iterations, if

$$u_i^k = u_i, \quad i = 1, 2, \ldots, m$$

and $v_j^k = v_j, \quad j = 1, 2, \ldots, n$

or $u_i^k / u_i = r_i^k = 1.0, \quad i = 1, 2, \ldots, m$

and $v_j^k / v_j = s_j^k = 1.0, \quad j = 1, 2, \ldots, n$

Further iterations would not alter the cells of the matrix, because each of our successive multiplier $r_i^k$ and $s_j^k$ would be unity. At this stage the procedure is stopped. The matrix so obtained will be our $A^*$ matrix. Therefore, we may write,

$$A^* = (a_{ij}^*) = (a_{ij}^k)$$
The row multiplier \( r \) and column multiplier \( s \) are product of respective multipliers obtained in each successive iteration. Mathematically,

\[
r = (r_i) \text{ where } r_i = r_1^i r_2^i r_3^i \ldots r_k^i \quad i = 1, 2, \ldots, m
\]

and \( s = (s_j) \text{ where } s_j = s_1^j s_2^j s_3^j \ldots s_k^j \quad j = 1, 2, \ldots, n\)

such that \( r_i a_{ij}^0 s_j = a_{ij}^* \quad i = 1, 2, \ldots, m \) and \( j = 1, 2, \ldots, n\)

The above mentioned method is known as the RAS method, and may be applied when a matrix is to be adjusted or updated to match a set of given totals. However, it involves two questions: (i) under what circumstances the system will converge? and (ii) since it is theoretically possible to have infinite number of matrices which will satisfy the given row and column totals, can the method be relied upon at all? These questions are answered by Bacharach (1970) along with mathematical proofs. We omit these proofs over her and just mention the results. It can be concluded from his proofs that (i) the system will definitely converge if the sum of the given row totals is equal to the sum of the given column totals. Mathematically,

\[
\sum_{i=1}^{m} u_i = \sum_{j=1}^{n} v_j
\]

40. We have not repeated the subscripts for \( r \) and \( s \). Thus, \( r_i = r_{ii} \) and \( s_j = s_{jj} \).
and (ii) given the $A_0$ matrix, and $U$ and $V$ vectors, the solution will give a unique adjusted matrix $A^*$. 

The RAS method discussed so far was in the context of making adjustments in a rectangular matrix which is a general case. However, the input-output matrices are square matrices and make a special case. For adjusting an input-output coefficient matrix, the row control totals are sectoral deliveries of material inputs (sectoral gross outputs minus sectoral final demands) and column control totals are sectoral receipts of material inputs (sectoral gross inputs minus sectoral gross value added and sectoral indirect taxes). Each column of the given input-output coefficient matrix is multiplied by the corresponding element of gross output vector associated to the unknown matrix, and flows thus obtained are adjusted to the given row and column control totals using RAS iterations. The matrix obtained is then converted into a coefficient matrix by dividing each column of the matrix by its corresponding gross input (or gross output). The $r$ and $s$ multipliers obtained by adjusting the flows are equally valid for the coefficient matrices.  

41. Denoting by $q$, a diagonal matrix containing the known gross output vector in its principal diagonal, the known coefficient matrix by $A_a$ and unknown coefficient matrix by $A_b$, we have,

$$A_b q = r (A_a q) s$$

f.n.contd..
The $r$ and $s$ multipliers

As mentioned earlier, the $r$ and $s$ multipliers obtained by RAS iterative procedure have economic interpretation. The row multiplier $r_i$ represents "substitution effect", indicating the extent to which output of sector $i$ has been substituted for, or replaced by, outputs of other sectors as an intermediate input into sector $j$. The column multiplier $s_j$ represents the 'fabrication effect', meaning, the extent to which output of sector $j$ has come to absorb a greater or smaller ratio of intermediate to primary inputs in its fabrication. However, these concepts of substitution and fabrication effects make sense in inter-temporal adjustments of the coefficients. Theoretically, it is also possible to have these effects, if a technology of production in a region, represented by an input-output coefficient matrix, is instantaneously adopted by another region having a different input endowment, which brings about changes in the coefficients leading to some adjustments in the technology.

where $r$ and $s$ are row and column multipliers, respectively, in the form of diagonal matrices, multiplying both sides by $q^{-1}$, we get,

$$A_b q^{-1} = r \left(A_a q q^{-1}\right) s$$

or $A_b = (r A_a s)$ because $q q^{-1} = I$. Therefore, we can say that the $r$ and $s$ obtained from the adjustment of the flow matrix are valid for the coefficient matrix as well.
Adjustment of $Z$ using the RAS method

The matrix $Z$ is for 1979-80 which has been brought to constant (70-71) prices using price deflators. This matrix is adjusted to rows and column control totals for 1979-80 at 1970-71 prices obtained from the NAS.

Our matrix to be adjusted is of the order 32 x 32 it should, however, be remembered that it is just a matter of chance that it is a square matrix. Any further aggregation or disaggregation of the components of final demand, primary inputs or imports may make it rectangular.

The control totals used to adjust the matrix are as follows.

**Vector $U$ - the row Control Totals:** This is a column vector of the order 32 in which first fourteen elements are sectoral gross outputs, fifteenth element represents total indirect taxes less subsidies, sixteenth through twentieth elements are sectoral gross value added at factor cost, thirtieth element represents value of total changes in stocks in the economy, thirtyfirst element is value of total oil imports (c.i.f.) and thirtysecond element contains c.i.f. imports other than oil imports.

**Vector $V$ - the columns Control Totals:** This is a row vector of the order 32. Like $U$ vector, $V$ also contains sectoral gross inputs as its first fourteen elements. Fifteenth and sixteenth elements in this vector are private final consumption expenditure and
government consumption, respectively, both at market prices. Seventeenth through thirteenth elements are sectoral gross domestic capital formation at market prices by sector of use (destination). Thirtyfirst element represents changes in stocks in the economy (same as thirtieth element of $U$ vector). Thirtys-second element contains f.o.b. total exports (inclusive of indirect taxes less subsidies).

Both the vectors $U$ and $V$ are at constant 1970-71 prices. The $Z$ matrix has a negative entry in the column for changes in stocks, indicating that the addition to stocks was smaller than withdrawals from the stocks of the output of agricultural sector. This was due to reduced procurement because of crop failure in that year (1979-80) and heavy withdrawals from food grain stocks for distribution under the "Antodya" programme. This negative entry has been taken out from our transaction matrix and from the corresponding values of $U$ and $V$ vectors. The matrix is now subjected to these control totals with the help of RAS interactions. The process achieved convergence in 27 iterations considering accuracy up to eight place of decimal. The negative value taken out from the $Z$ matrix is now put back into it and $U$ and $V$ vectors are adjusted accordingly. Thus, now we have a matrix $Z_a$ obtained by adjustments in $Z$.

42. This means when all the multipliers attain values between .99999999 and 1.00000001.
To judge the changes brought by the RAS method in the \( Z \) matrix, Mean Square Percentage Difference (MSPD) was computed, which turned out to be 0.02287 (100 per cent). About 92 per cent of the non-zero cells showed either no change or a change less than ±0.5 per cent, while 7 per cent cells showed changes less than ±5 per cent, only one per cent cells had more than 5 per cent changes. It would be interesting to note that large percentage changes are observed in those cells whose values have very small proportions in the matrix. It is noteworthy that in our case the \( r \) and \( s \) multipliers cannot be interpreted as substitution and fabrication effects as the RAS method has been used to match the totals of the transaction matrix obtained from the Technical Note with those available in the NAS.

The adjusted transaction matrix \( \overset{\text{\textregistered}}{Z} \) is now converted into a coefficient matrix by dividing each column of the matrix by its respective total. Mathematically, if we denote a digonal matrix by \( V \) which

43. For a matrix, this may be defined as,

\[
\text{MSPD} = \frac{1}{N} \sqrt{\sum_{i=1}^{m} \sum_{j=1}^{n} \left( \frac{A_{ij} - \overset{\text{\textregistered}}{a_{ij}}}{A_{ij}} \right)^2}
\]

where \( A_{ij} \)'s are the elements of unadjusted matrix and \( \overset{\text{\textregistered}}{a_{ij}} \)'s those of adjusted matrix. \( N \) is the total number of non-zero cells in the matrix.
Fig. 3.2

COEFFICIENT MATRIX CORRESPONDING TO MASTER TRANSACTION TABLE

\[
\begin{array}{cccccccc}
\text{a}_{ij} & \text{c}_j & \text{g}_i & \text{k}_{ij} & \text{s}_i & \text{e}_j \\
\hline
\text{t}_j & \text{t}_e & \text{t}_g & \text{t}_{kj} & 0 & \text{t}_{ej} \\
\text{b}_{ij} & 0 & 0 & 0 & 0 & 0 \\
\text{m}^* & \text{cm}^* & \text{gm}^* & 0 & 0 & 0 \\
\text{m}_j & \text{cm} & \text{gm} & \text{km}_j & 0 & 0 \\
0 & 0 & 0 & \text{q}_j & 0 & 0 \\
U & 1 & 1 & U & 1 & 1 \\
\end{array}
\]
contains the vector $V$ in its principal diagonal and the coefficient matrix by $Z^*$, we have

$$Z^* = Z_a \cdot V^{-1}$$

Diagramatic representation of $Z^*$ is given in figure 3.2, in which partitions are same as that in our original transaction matrix. The numerical values for the cells of the partitions of $Z^*$ are presented in Appendix A (See table for 1979-80).

We now explain various coefficients in the $Z^*$ matrix. All these coefficients are at constant 1970-71 prices.

**Production Activity**

$a_{ij}$ = output of sector $i$ required by sector $j$ per rupee of sector $j$'s output.

$t_j$ = indirect taxes less subsidies per rupee of sector $j$'s output.

$b_{ij}$ = gross value added in sector $j$ per rupee of its output for $i=j$.

= 0 ; for $i \neq j$.

$m_j^*$ = oil imports required per rupee of sector $j$'s output.

$m_j$ = import other than oil, required per rupee of sector $j$'s output.

$$\sum_{i=1}^{14} a_{ij} + t_j + b_{jj} + m_j^* + m_j = 1 \text{ rupee worth of gross input (output) of sector } j, j = 1, 2, \ldots, 14.$$ 

2. **Private Consumption**

$c_i$ = proportion of output of sector $i$ consumed in one rupee worth of private consumption at market prices.
\[ t_c = \text{proportion of indirect taxes less subsidies in one rupee worth of private consumption at market prices.} \]

\[ cm^* = \text{proportion of oil imports in one rupee worth of private consumption at market prices.} \]

\[ cm = \text{proportion of imports other than oil in one rupee worth of private consumption at market prices.} \]

\[
\sum_{i=1}^{14} a_i + t_c + cm^* + cm = 1 \text{ rupee worth of private consumption at market prices.}
\]

3. **Government Consumption**

\[ g_i = \text{proportion of output of sector i in one rupee worth of government consumption at market prices.} \]

\[ g = \text{indirect taxes less subsidies in one rupee worth of government consumption at market prices.} \]

\[ gm^* = \text{proportion of oil imports in one rupee worth of government consumption at market prices.} \]

\[ gm = \text{proportion of imports other than oil in one rupee worth of government consumption at market prices.} \]

\[
\sum_{i=1}^{14} g_i + t_c + gm^* + gm = 1 \text{ rupee worth of government consumption at market prices.}
\]

4. **Investment (Gross Domestic Capital Formation)**

\[ k_{ij} = \text{output of sector i required by sector j for investment per rupee of gross domestic capital formation in sector j at market prices.} \]

\[ k = \text{proportion of indirect taxes less subsidies in one rupee worth of gross domestic capital formation in sector j.} \]

\[ km_j = \text{proportion of imports (non-oil) in one rupee worth of gross domestic capital formation in sector j at market prices.} \]

\[ k_j = \text{changes in stocks in sector j per rupee worth of gross domestic capital formation in sector j.} \]

\[
\sum_{i=1}^{14} k_{ij} + tk_j + km_j + q_j = 1 \text{ rupee worth of gross domestic capital formation at market prices in sector j. j=1,2,...,14.}
\]
5. **Changes in Stocks**

\[ s_i = \text{output of sector } i \text{ required per rupee worth of changes in stocks in the economy.} \]

\[ \sum_{i=1}^{14} s_i = 1 \text{ rupee worth of changes in stocks in the economy.} \]

\[ \sum_{i=j}^{14} q_j \overline{I}_j = \overline{S} = S \]

where \( \overline{I}_j \) is gross domestic capital formation at market prices in sector \( j \).

Also, if \( K^* = (K_{ij}) \), that is, coefficients corresponding to partition \( K \) of \( \overline{Z} \) matrix given in figure 3.1, and \( KF \) is the row vector of gross domestic fixed capital formation net of direct imports and indirect taxes less subsidies by sector of use (destination), then \( KF = \overline{U} K^*(\overline{I}I) \); where \( I \) is an identity matrix and \( \overline{U} \) a unit row vector.

Similarly, if \( KD \) denotes a column vector of total requirements of sector \( i \)'s output for gross domestic fixed capital formation net of direct imports, or in other words, gross domestic fixed capital formation net of direct imports by industry of origin and indirect taxes less subsidies, then

\[ KD = K^* \cdot \overline{I}' \]

6. **Exports**

\[ e_i = \text{proportion of output of sector } i \text{ exported in one rupee worth of total exports (f.o.b)} \]

\[ t_e = \text{proportion of export duties plus indirect taxes less subsidies per rupee of total exports (f.o.b)} \]
Thus, $e_m + t_e = 1$ rupees worth of exports (f.o.b).

Finally, we would like to identify the partitions $c_i, g_i, k_{ij}, s_i$ and $e_i$ with a single name $F$, which contains coefficients pertaining to domestic gross output (at factor cost) net of direct imports. This matrix $F$ will be used to convert the various final demand components into total sectoral final demands and sectoral prices to prices of final demand components. The partition $F$ is shown by bold lines in figure 3.2.

3.4 Changing Coefficients

The behaviouristic part of our model would be estimated from time-series data and our intended simulation exercises would be overtime. We would also require coefficient tables similar to $Z^*$ for each year whose various partitions would be used in these simulations.

The controversy about fixed input-output coefficients no more exists and economists agree that the input-output coefficients do change over time for two reasons: One, relative changes in the prices of output and, second, due to changes in the technology over time.\(^{44}\)

The direct effect of the relative changes can be understood with the help of the following example.

\(^{44}\) See Stone, et. al. (1963), Preston (1972), Klein (1983).
Let $X_{ij}$ denote the physical quantity of output of sector $i$ required by sector $j$ to produce $X_j$ physical units of output. If we denote the input-output coefficient by $a_{ij}$ in physical terms, then clearly,

$$a_{ij} = \frac{X_{ij}}{X_j}$$

If $P_i$ and $P_j$ are prices of the output of sector $i$ and sector $j$, respectively, then, denoting the same input-output coefficient in money terms by $a^*_{ij}$, we have

$$a^*_{ij} = \frac{P_i X_{ij}}{P_j X_j} = a_{ij} \frac{P_i}{P_j}$$

Thus, we see that the input-output coefficients in money terms are function of relative price $P_i/P_j$ even if the input-output coefficient in physical terms remains fixed. It is also possible to show that and alteration in relative prices of one input-output coefficient or even in the price of output of one sector will alter all the coefficient in that column. The change does not remain confined to the column in which the coefficient is located, but such a change in relative prices also alters the row to which the coefficient belongs and consequently the entire matrix is adjusted accordingly. The change in just one cell in the monetary coefficient leading to change in entire matrix may be considered analogous to throwing a stone in a pond of water with calm surface, which produces ripples in the entire surface of the water.
with various amplitudes, amplitude being highest where the stone strikes the surfaces and moving in all directions with dampening amplitudes.45

Changes in technology being brought about by innovations also lead to changes in input-output coefficients through substitution and fabrication phenomena. The effects of change in technology leading to change in even a single call is also expected to be transmitted to the entire matrix.

In the context of developing economies like ours, there may be a third source bringing about year to year changes in the input-output coefficients. This source is the rainfall. Since our economy is not efficient enough to convert inputs into output in the agricultural sector due to lack of facilities for timely and assured irrigation, the agricultural output greatly depends upon timely and suitable amount of rainfall. Because there is a substantial lag between inputs being put into the agricultural production process and output being produced, the decision regarding putting the inputs is to be taken in almost total darkness about the future weather conditions.46

45. This is termed as the 'ripple effect'. See Stone, et. al. (1963).

46. Though a famous Hindi poet "Ghag" puts his observations in his couplets to predict weather conditions. For example he mentions,

"Ek boond jo 'Chait' main pare, sehas boond 'Sawan' main hare."

A single drop of rain in the month of Chait (around April) would deprive us of thousand drops of rain in the month of Sawan (around July), i.e. monsoon.
Thus, if there is a crop failure, the input-output coefficients for agricultural sector will be increased in physical terms, and vice-versa. Further if the price of output does not increase to perfectly match the reduction in output, the monetary coefficients will also increase and vice-versa. Even a matching increase in the prices of gross output of agricultural sector will not assume stable coefficients unless prices of output of other sectors remain stable and do not change in response to agricultural prices. Thus, input-output coefficients for the agricultural sector are expected to oscillate over time according to weather conditions. Even if we assume no relative price and technological changes, these oscillations will take place. As mentioned earlier, these changes will be transmitted to the entire economy.

In an extreme case of crop failure, it may also be possible to have the input-output coefficient column for agricultural sector in a matrix for which total of coefficients exceeds unity. Our matrix $Z^*$, which has not only input-output coefficients but many other types of coefficients, the changes in coefficients can be brought about due to several reasons. Say, for example, the proportions of sectoral outputs in private consumption may change due to changes in, income distribution, tastes and demonstration effect, etc., and those of government consumption due to change in government policies.
Similarly, the changes in the world demand patterns and government policies regarding export incentives and duties may lead to changes in the export proportions.

Fulfilment of demand for higher wages on the part of workers, attempt to earn more profits (windfall or normal) on the part of entrepreneurs and traders, increased interest rates and increased rents can alter the coefficients for the gross value added.

Changes in indirect taxes and subsidies by the government and changes in prices of imported items for production, as well as for consumption and investment, all can influence few or all of our coefficients.

To take care of these changes, various methods have been devised. The Planning Commission applies a mixed type of technique (modified RAS method), in which certain cells are estimated outside the RAS framework and are removed from the tables and control totals. The remaining table is adjusted using the RAS method and exogenously estimated cells are put back into the table. In the Fifth Plan Technical Note the Planning Commission has exogenously altered a few coefficients of the base year table and assumed rest of the matrix to be the same for the terminal year. This, perhaps, was done because the RAS method required the gross output vector for the year for which the input-output coefficient matrix is to be obtained and the Planning Commission required an input-output matrix for that year to estimate the gross output
vector for the same year. Thus, it would not have been possible to apply the RAS technique, and hence most of the coefficients of the base year matrix would have been assumed stable over a period of five years, of course, implying an assumption which has not been mentioned in the document, that no relative price or technological changes will take place during these five years and rainfall conditions would remain same as that of base year for each year of the plan period, or at least, for the terminal year.

The problem of changing coefficients has been given different treatment by different researchers and organisations. Usually, in case of Leontief type of analysis, the RAS and exogenous projections are the popular ones. However, in the hybrid type of models, i.e., those incorporating both input-output and behaviouristic structures, "modelling of residuals" has been done apart from applying the RAS method. For instance, Preston (1972) relies upon modelling the residuals in the Wharton Annual and Industry Forecasting Model. The input-output part of the model is based on an input-output table for the American economy for 1958. Using the matrix for all time periods, sectoral gross value added are estimated which are then compared with their respective observed figures. A series of difference between observed and estimated values is obtained. With these differences, model of residuals for each industry
in his classification, has been constructed using an autoregressive scheme. Such a treatment of residuals using a regression model to adjust for coefficient change, however, will not preserve the national income accounting identity mentioned earlier in our text, i.e., sum of sectoral gross value added should equal total final demand. This identity will be satisfied, if and only if, same set of regressors are used in each equation.

The approach followed by Preston is quite similar to that followed by Kresge (1969) and also by Fisher, Klein and Shinkai (1969).

In the Brookings Model, regression techniques are used to obtain estimates for starting constrained biproportional procedure (RAS) to handle the problem of changing coefficients. Such estimates are obtained for each quarter of the model. This approach produces satisfactory results for the sample period simulations.

In our model we would, however, give an exogenous treatment to the changing coefficients. This exogenous treatment becomes necessary due to apprehension, that the input-output table which matches the available sectoral data is for almost the end period of our sample series.\[47\]

\[47\] Our sample period is form 1960-61 to 1980-81 and the matching table is for 1979-80.
and it can create problem if it is used for past, without making adjustment. This would become clear from the following example. Let us now try to proceed on the lines of Wharton Model, then, while "modelling the residuals", we may have to adopt a formulation of the type,\(^{48}\)

$$u_{it} = f(u_{it-1}, t) + e_{it}$$

or

$$u_{it} = f(u_{it-1}, u_{it-2}, t) + e_{it}$$

where \(u_{it}\) is the "residual" for industry \(i\) for period \(t\) and \(e_{it}\) is the corresponding error term in the regression equation. This system moves forward over time but our input-output table is for future and using it, say, for our first time period, is bound to create problems. Thus, we need a system which moves backward, i.e., a system of the type

$$u_{it-1} = f(u_{it}, t) + e_{it}.$$ 

It would be an altogether senseless idea to say that residuals in the past were generated due to residuals in the future. However, we do need some accounting for changing coefficients. Thus, we generate a series of coefficient tables \(Z^*\)'s corresponding to Master Transaction Tables \(\tilde{Z}_a\)'s.

---

3.3.4.1. **Series of Master Transaction Tables:**

We now describe generation of a series of coefficient tables as per our requirement. For doing this, row and column control totals are obtained using data from the NAS and the RCF according to method described in the context of the RAS adjustment. Thus, we now have $U_t$ and $V_t$, where $U_t$ is the vector of row control totals and $V_t$ is the vector of column control totals, both at constant 1970-71 prices for period $t$. These control totals are enforced on the $Z^*$ matrix using the RAS technique, to obtain estimate of coefficient tables for each year. To make the process clear, we take it up in detail.

Our $Z^*$ matrix is at constant 1970-71 prices, for the year 1979-80. This matrix has been adjusted for the past, as well as, for the future, with the help of the RAS iterative procedure. Algebraically it may be expressed as,

$$Z_{t-1}^* = r_t (Z_t^*, V_{t-1}) s_t ; t = 1979-80, 1978-79, ...1961-62$$

for the past, and for the future, we have,

$$Z_t^* = r_t (Z_{t-1}^*, V_t) s_t ; t = 1980-81, 1981-1982$$

where $Z_t^*$ is the $Z^*$ matrix for period $t$, $r_t$ and $s_t$ are, respectively, the row and column multipliers for converting the $Z^*$ matrix from period $t$ to period $t-1$ in the case of backward movement and from $t-1$ to $t$ for the forward movement.
However, in cases of obtaining matrices for immediately preceding and following year, i.e., 1978-79 and 1980-81 the negative cell in the Changes in Stocks column against Agricultural sector was removed from the $Z^*$ matrix, and also present $V$ and $U$ vectors. The cell was exogenously estimated and introduced back after the RAS adjustment. To obtain the cell exogenously, Changes in Stocks for Agricultural sector were worked out from the available data and divided by total Changes in Stocks in these years.

The partitions of matrices obtained using the RAS process are given in appendix A for all the 22 years of our sample period.

Let us now examine a few cells of these matrices.

First, we examine some trends in few of these coefficients. For this purpose, both linear and semi-logarithmic trend equations have been estimated for three periods, viz, 1960-61 to 1969-70, 1970-71 to 1981-82 and the entire period 1960-61 to 1981-82. Apart from these trend equations, mean, standard deviations around mean (SD), coefficient of variation (CV) and standard deviation around trend line (SDT), have also been computed for the three time periods mentioned above. These statistics would be helpful in deciding the behaviour of a coefficient overtime if it shows no trend. A low CV would indicate that the

49. Data regarding Changes in Stock for the Agricultural sector are available in the Bulletin on Food Statistics and Bulletin on Commercial Crops, both published by Ministry of Agriculture, Government of India. The data are in physical units which have been converted to value terms using 1970-71 prices.
coefficient remained stable over time, where as a high value of CV indicates oscillation of coefficient around the mean value. A substantial difference in SD and SDT, when there is no statistically significant trend in the coefficient, linear or semilog, may be considered as an indication of some trend in the coefficient with random oscillations.

In the discussion which follows, period 1 refers to the period between 1960-61 and 1969-70 (both years inclusive)\(^{50}\). Similarly, the period between 1970-71 and 1981-82 is refered to as period 2. The term "growth rate" stands for average annual compound growth rate using semi-logarithmic trend equation, unless specified.

**Input Coefficients for Agricultural Sector:**

The proportion of inputs taken from itself, in one rupee worth of total inputs (or gross output) remained almost stable over time during our sample period (CV = 5.05). The mean value turns out to be .11453. However, there appears to be a small change in the mean values of the coefficients overtime. These means are .11657 and .11283 respectively, for period 1 and period 2. Associated CV's are 5.01 and 4.56 respectively. No statistically significant growth rate is observed in these

---

50. Table 3.3 presents the semilogarithmic growth rate for the period 1960-61 to 1981-82.
Table 3.3
TRENDS IN COEFFICIENTS: Semi-logarithmic Growth rates for elements of Z* matrix

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| GVA  | -.2 | -.2 | -1.2 | .9**| -1.5*| -.2 | -.2* | -1.1*| .5* | .4* | -.4* | -.3* | -   | -   | -   |
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| MG   | .2  | -   | -   | 1.7*| -.2**| 2.0*| -.5 | -   | 7   | -.3.8*| -   | -   | -   | 1.3**| 1.1**| 2.3*|
| Q    | -   | -   | -   | -   | .1**| 2.2*| -.5 | -   | -   | -   | -   | -   | -   | -   | -   |

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Note: (i) Values represent semi-logarithmic growth rate in coefficients showing deliveries from i to j in one year of j.

(ii) *, ** and *** denote statistical significance at 1, 5 and 10 percent respectively.

(iii) Abbreviations with small case letters represent respective columns for investment by sector of use. C and G are private and government consumption respectively.
coefficients. The finding is an expected one as this coefficient is not expected to significantly change over time, because it mainly reflects value of seeds taken by agriculture from itself, farm yard manure taken from Animal Husbandry (which forms part of Agricultural sector in our classification) and fodder being given to Animal Husbandry.

The Coefficient showing proportion of inputs purchased from Manufacturing sector shows statistically significant growth at 1% level of significance for all the three periods. The coefficient grew at a rate of 2.64% during our sample period, at 5.5% during period 1 and 3.35% during period 2. High growth rate for period 1 is obviously due to adoption of new technology in the late sixties (green revolution), which increased dependence of Agriculture on Manufacturing sector. However, due to large base of the coefficient for our second period growth rate, we get a value smaller than that for period 1.

Use of Electricity, per rupee of gross output shows very high and statistically significant growth rate at 1% level of significance, for all the three periods. They are, 8.44, 6.73 and 6.5 per cent respectively for the period 1, the period 2 and the entire period. These growth rates indicate more and more use of electricity per rupee of gross output in the Agricultural sector. Another sector which is supplying increased inputs to Agricultural sector is the Services sector. The coefficient for inputs
per rupee of gross output going from Services to Agriculture shows growth at 6.7, 2.9 and 3.47 per cent for the period 1, the period 2 and the entire sample period, respectively. These rates are also statistically significant at 1% level of significance.

Coefficient showing use of imported inputs also show slight increases over time. However, the growth rate is statistically significant for period 2 only, for which its value turns out to be 2.53%.

The proportion of gross value added in one rupee worth of gross output declined at the rate of .42% during period 1 which continued to decline at almost the same rate, i.e., at .40% in period 2. However, the growth rate for the entire period shows a slower decline, its value being .19 per cent. All the three rates are statistically significant at 1% level of significance.

Input Coefficients for Manufacturing Sector:

The inputs being purchased from the Agricultural sector by this sector, show a growth rate of -.83%. The growth rates for the period 1 and the period 2 are almost the same, i.e., -1.22% and -1.06% respectively. However, the rates are significant at 1% level for the period 2 and the entire period and for the period 1, the level of significance is 5%. The coefficients showing inputs from Mining and Quarrying to Manufacturing did not show any statistically significant change during period 1 (CV=3.37).
The low value of CV suggests that the coefficient almost remained stable around the mean value .01705 in this period. However, in period 2 the coefficient changes at a rate of -1.4%, which turns out to be significant at 1% level. For the entire period, it shows a change at -.76% and is significant at 1% level.

Purchases of inputs per rupee of gross output by the Manufacturing sector from itself show a substantial increase over time, the growth rates being 3.84, 1.70 and 1.89 per cent for the period 1, the period 2 and the entire period, respectively. All these rates are significant at 1% level.

Electricity input to Manufacturing per rupee of gross output increased at a very highly significant rate. During the sample period it increased at 5.72%. For period 1 the growth rate is higher than that for period 2, values for these growth rates are 6.73 and 5.02 per cent, respectively. The significance may be considered from t-values for the slope coefficient of the semilogarithmic trend lines, which turn out to be 22.648, 21.840 and 45.544 respectively for the period 1, the period 2 and the entire period. Purchase of Railway services by the Manufacturing sector per rupee of its gross output also show an increase at .47% during the sample period. The growth rate is higher (1.71%) and significant at 1% level for the period 1 but for the period 2, it turns out to be -.44% and statistically not different from zero. Thus,
during our period 2 the coefficient of Railways in Manufacturing remains almost stable around a mean value .00931 (CV=.03%).

The services purchased by the Manufacturing sector per rupee of its gross output from 'Other Transport' show highly significant growth rates for all the three periods. The growth rate for entire period turns out to be 4.66 per cent. It is 4.14 per cent for the period 1 and 4.39 per cent for the period 2. The t-values associated with the slope coefficients of the semilogrithmic trend line are 28.333, 8.414 and 15.483 for the entire period, the period 1 and the period 2, respectively.

An increase in the growth rate of coefficient for 'Other Transport' during the period 2 and stability of the coefficient for Railways in the corresponding period may be interpreted as showing greater reliance of the Manufacturing sector on Other Transport as compared to Railways. The coefficient for the purchases of Banking and Insurance services by the Manufacturing sector shows growth at 3.48 per cent during our sample period and is statistically significant at 1% level of significance. The growth rate is 1.3 per cent for the period 1 and more than double for the period 2, i.e., 3.02 per cent. Both these rates are also significant at 1% level. These rates show more and more use of Banking and Insurance services by the Manufacturing sector over time.
The use of Services by the Manufacturing Sector in the period 1 increased at a statistically significant growth rate at 1% level of significance. The rate was 5.02 per cent. However, the coefficient turns out to be stable during the second period around a mean value of .01095 with some oscillations (CV=8.98%).

Oil imports per rupee of gross output of the Manufacturing sector increased at a rate of 5.25 and 5.16 per cent in the period 1 and the period 2 respectively. However, for the entire period, the growth rate turns out to be 4.05 per cent. All the three rates are significant at 1% level.

The Imports other than oil per rupee of gross output of the Manufacturing sector do not show any significant growth rates over time. The value of the input coefficient remained stable over time around a mean value of .04469 with moderate oscillations (CV=15.7%). The mean value for the period 1 is .04818 (CV=13.7%) and that for the period 2 is .04179 (CV=14.2%). Share of gross value added in gross output declined at 1.5 per cent during our sample period in this sector. The decline was faster in the period 1, at 2.32 per cent, and relatively slower in the period 2 (1.61 per cent). The three rates are statistically significant at 1% level.
Input Coefficient for Construction Sector:

Use of output of the Manufacturing sector per rupee of gross output of the Construction sector increased at 3.51, .46 and .73 per cent, respectively during the period 1, the period 2 and the entire sample period. All these rates turn out to be statistically significant at 1% level.

Purchases of Electricity by the Construction sector rose at 6.38, 3.74 and 4.52 per cent in the period 1, the period 2 and the entire period, respectively. The t-values associated with the slope coefficients of the semilogrithmic lines for the three periods are 12.086, 14.571 and 23.975, respectively. It would be interesting to note that the linear fit for this input coefficient, as judged from t-values, shows much stronger relationship for period 2 and the entire period. The linear growth rates, computed on the estimated value of the input coefficient for the first year as the base, are 8.58, 4.52 and 7.55%. The t-values for slope coefficient of the linear trend line are found to be 11.391, 15.281 and 35.483, respectively. Use of 'Other Transport' and 'Banking and Insurance' services per rupee of gross output by this sector show statistically significant increase over time.

Share of gross value added shows a significant growth rate of -2.29 per cent during the period 1, but during the period 2 it remains highly stable over time.
around a mean value of .41087 with a CV of .002% only. For our entire sample period the mean value turns out to be .40051 with some oscillations (CV=5.74%).

Trends in some important input coefficient related to three major sectors of the economy have been discussed so far. About 60 to 65 per cent of the real national income originates from these three sectors, viz. Agricultural, Manufacturing and Construction. Rest of the sectors contribute about 35 to 49 per cent towards real national income, and hence we do not take up their coefficients in detail. However, it would be proper to discuss some trends in general.

A glance at table 3.3 reveals that the proportion of the gross output of the Manufacturing sector shows significant increase in the production, as well as, in the final demand except that in 'Trade, Hotels and Restaurants' and 'Real Estate and Ownership of Dwelling' sectors, where a decline is indicated.

The share of the gross output of the Construction shows a mixed trend, with growth rates varying between -5.79 and 4.96 per cent. Both, statistically significant and insignificant growth rates\(^{51}\) appear for this sector.

\(^{51}\) Insignificance of these growth rates is also important in our case as it indicates either stability of a coefficient over time or oscillations in the value of the coefficient around some central value.
'Electricity, Gas and Water Supply' as input and as consumer good (for final demand) has highest growth rates for its share. Except for 'Banking and Insurance' sector, the share of 'Electricity, Gas and Water Supply' has very high and statistically significant growth rates varying from 2.29 per cent in the 'Real Estate and Ownership of Dwellings' sector to 8.45 per cent in the Mining and Quarrying sector. In Agriculture it increased at 6.5 per cent and that in Manufacturing by 5.72 per cent. Its share in private and government consumption has grown at 5.46 and 4.26 per cent respectively.

The share of Railways has a mixed tendency with some of the growth rates being statistically insignificant or moderately significant.

The 'Other Transport and Storage' sector again shows moderate to high positive significant growth rates for its share in various production activities and also in the final demand, except in the 'Communications' and Banking and Insurance' sectors. The positive growth rates are between 1.26 in the Real Estate and Ownership of Dwellings' sector and 7.37 in the 'Mining and Quarrying' sector. The increase in its share in the private and government final consumption is 4.41 and 3.21 per cent, respectively.

Most of the growth rates for the share of 'Banking and Insurance' are positive and statistically significant.
Use of 'Other Services' has also increased in production as well as in the final demand.

Share of Oil imports appear to have increased, both in production and in consumption, at rates varying between 2.61 and 4.21 per cent per annum. However, the share of Imports other than Oil has decreased in production, as well as, in the final demand, at rates between -3.79 and -4.45 per cent, except in the Mining and Quarrying, in which it has increased at 1.67 per cent.

The share of gross value added in the gross output has declined in Agriculture, Forestry and Logging, Fishing, Mining and Quarrying, Manufacturing, 'Electricity, Gas and Water Supply', Railways and 'Other Transport' (growth rates being -0.19, -0.23, -0.11, -0.91, -1.50, -2.03, -0.21 and -1.10 per cent respectively). In the rest of the sectors it increases at rates between 0.19 and 0.54 per cent. All growth rates, positive or negative are statistically significant at 1% level of significance, except those for Forestry and Logging, Construction and Services sector.

The sectors showing decline in the share of gross value added in their respective gross output contribute more than 60 per cent towards the real gross domestic product at 1970-71 prices and hence the decline in the share of gross value added in the gross output is also reflected in the aggregated figures. The phenomenon may be indicative of more and more use of material inputs and various services in the production process, and hence
the share of primary inputs in the gross output has declined over time.

Before concluding, let us examine the private and the government consumption expenditures. Share of Agricultural output has declined at -1.08 and -2.20 per cent, respectively, in both private and government consumptions, whereas that of outputs of Manufacturing, 'Electricity, Gas and Water Supply', 'Other Transport', 'Communications', 'Banking and Insurance' and Services sectors has increased. Share of 'Real Estate and Ownership of Dwellings' sector also shows an increase in the private consumption. The share of Railways has remained stable overtime in the private consumption (statistically insignificant growth rate of .22 per cent) whereas in the government consumption it has declined at a significant moderate rate of -.92 per cent per annum. Shares of 'Forestry and Logging' and 'Trade, Hotels and Restuarant' have declined at statistically significant rates in both private and government consumption.

The increase in the intermediate and final use of manufactured items, 'Electricity, Gas and Water Supply', 'Other Transport', 'Banking and Insurance' and 'Other Services' alongwith decreased intermediate and final use

52. 'Real Estate and Ownership of Dwellings' do not have any share in the government consumption. Similarly, Construction has no share in the private consumption.
of Agricultural gross output may be interpreted as pointing toward the development of the economy. Reduced use of Imports other than Oil may be considered as indicative of import substitution taking place in the country.

Assuming that our economy is developing, which is not countrafactual, trends in various coefficients of our matrix are expected ones and not contrary to common sense appeal and economic reasons. We may, therefore, accept our series of coefficient matrices for being used in our model.