A SURVEY OF APPLICATION OF INPUT OUTPUT MODELS

Ranajit Dhar*

Professor, Indian Institute of Management, Bangalore.

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01 : Introduction.

Everything depenos on everything else. This means that every economic activity has important backward and forward linkages with every other activity. Consequently, if output of one activity increases due to demand increases, it requires all its inputs also to be made available through production and/or imports. In the next stage, inputs of the domestically produced inputs also will have to be made available, and so on and on. Any bottlenecks in the supply of all these chain of inputs may create serious production bottlenecks. The possibility of any such structural imbalances in which shortages in certain sectors and surpluses in certain other group of sectors can occur, provide the most persuasive arguments for the study of structural interdependence using input output techniques.

The existence of such sectoral inter-dependence in a national economy has long been acknowledged by economists, but the systematic use of such interdependence for the construction of input output models is of comparatively recent origin. This consciousness of interdependence is traceable even to the writings of the Physiocrats, and came into prominence in the writings of Pareto, Walras, and many other economists of classical repute. But their treatment of the subject was too general and vague to be of use to practical economists, and the first input output model was constructed by Professor **Leontief (1936)** for the U.S economy in the early 1930s.

An Input Output (IO) Model has several important uses.

* It provides an excellent statistical picture of structure and functioning of an economy within a brief compass;

* It is useful in estimating national income within the framework of a Social Accounting Matrix (SAM) ;

* It is the only available technique for developing all types of multi-sectoral consistency and optimising models.

Chenery (1963) has provided an elaborate discussion on the need for as well as the limitations of using input output models for the study of the growth of developing countries.

Initially, at a very low level of per capita GNP in a developing country, the share of industry in GNP will be very low. This share will increase with the level of GNP increasing.

Most of the industrial current inputs will initially be imported as viable production capacity will in most cases not exist. Gradually domestic capacity will start increasing with GNP increasing and import substitution will start operating.

Capital inputs, technology and know-how etc. will also be initially imported and gradually substituted by domestic capabilities.

Exports, which will mostly constitute primary products initially will start diversifying to include more and more manufacturing items.

Input Output methodology can be used to study all these important structural changes. However, there will be need for borrowing and up-dating of the necessary technological coefficients, and also study the expected changes in the structure of composition of sectoral final demands. Input Output technique may help to work out future balances between demands and supplies for the target year of the plans.

Ever since the publication of **Leontief's (1936) pioneering** work on input output (IO) methods it created highly stimulating influences among economists and statisticians at both theoretical as well as empirical levels all over the world. Norway was one among the first countries to use input output analysis for economic projections during its reconstruction phase in the early 1950s. The countries like the Netherlands and Italy also later started using IO method during their reconstruction period for obtaining the necessary economic projections. Subsequently, the developing countries of Asia and Africa used this method as an aid in development planning. To date, more than 100 countries have constructed input-output tables. The list includes all shades of ideologies - Western market-oriented, and Socialist-oriented countries as well as the developing countries.

Input Output studies conducted in the different countries include the analysis of a very diverse group of problems and issues of an economy. This method has been integrated into the System of National Accounts (SNA) of UN Statistical Commission. Efforts have also been made to incorporate appropriate treatment of by-products and joint products **(Stone, 1961)**.

During 1960s and 1970s number of input output studies were directed towards assessing the economy-wide economic impact of changing technologies, methods for updating input output coefficients, and the uses of dynamic input output models.

Chenery and Watanabe (1958) have carried out a study involving international comparisons of the structure of production using the tool of input output analysis. The objective of this analysis was to shed light on the basis of international trade, the mechanism of economic growth and the analysis of other economic issues requiring an empirical knowledge of the nature of inter-dependance.

Weisskoff and Wolff (1975) studied the need for import flows and import dependence as related to the process of rapid industrialisation in developing countries.

Input Output methods have also been used in energy modelling **(Harendeen & Bullard, 1974)** as well as the studies on environmental protection **(Leontief, 1966; Carter AP, 1974)**.

Leontief (1974) has used input output methods to study the structure of the world economy.

Multi-sectoral optimising models using Input output relations have been developed to study the feasibility of providing adequate basic needs as an important pre-condition for speedy poverty alleviation and employment generation in developing countries **(Dhar and Rao, 1983)**.

Large number of studies have also been carried out to ascertain the changes in the relative price structure of an economy as a result of changes in indirect tax structure in the Government budgets. A number of such studies have been discussed in **Section 2**.

Regional and Multi-regional Input Output analysis have occupied a very important place in development planning. These are discussed in **Section 3**.

Other important areas of study cover the coefficient matrix and the problem of aggregation and the potential errors and biases.

The construction of input output models for the Indian economy was initiated in the Indian Statistical Institute, Calcutta, during the first half of 1950s as part of planning and development studies of the Indian economy. The first elaborate input output table published for India was for the year 1953-54 **(AK Chakravarthy, 1968)**. **Manne and Rudra (1965)** later prepared an input output table for 1960 and used it for obtaining sectoral projections for the Indian economy during the **Fourth** Plan. **Planning Commission (1973)** prepared an input output table for 1965, updated for 1973-74 and used it for obtaining alternative projections for the Fifth Plan.

Technical notes on the **Fifth, Sixth and Seventh** Plans have been prepared and are available in published form **(Planning Commission, 1973, 1981, 1986)**. The Central Statistical Organisation, Department of Statistics, Planning Commission, Government of India have now undertaken the work on constructing input output transaction tables regularly once in every five years. These tables for 1973-74 **(CSO, 1981)**, 1978-79 **(CSO, 1989)** and 1983-84 **(CSO, 1990)** are now available with CSO. Like many other countries like Japan, Norway etc. the construction of input output transaction tables in India regularly have now been institutionalized.

As of now more than 1000 books have been published on this subject in the different countries. Every year a few hundred articles appear in reputed journals, namely, American Economic Review, Econometrica, Review of Economic and Statistics, Regional Science and Urban Economics, etc. Already 10 International Conferences have been held in the different countries so far (Driebergen, Holand, 1951; Varenna, 1954; Geneva, 1961; Geneva, 1968; Geneva, 1971, Vienna, 1974; Innsbruck, Austria, 1979; Sapporo, Japan, 1986; Keszthely, Hungary, 1989; and, Seville, Spain, 1993). The Eleventh International Conference is due to be held in India during December 1995.

An International Input Output Association has been registered on April 12, 1988 with its current headquarter at Vienna, Austria. The Association is bringing out a journal "Economic Systems Research" published by the Carfax Publishing Company in England. Prof. A Brody of Hungarian Academy of Sciences, Institute of Economics, P.O.B. 262, H-1502, Budapest, Hungary, is the Chief Editor. The issue commences from March 1989.

Input Output Research Association (IORA), India, was founded during 1965. Since then IORA has organised number of all India seminars, and the proceedings of these seminars have also been published **(Mathur, 1965, 1967, 1970 1973)**. The Department of Economics, Bombay University, is the current headquarter of this Association. In India large number of academicians are currently engaged in research in input output analysis both at the academic and government circles to strengthen necessary research in this area.

02 : Prices & Incomes in an Input Output Model.

Following the contributions of **Leontief (1947)**, multisectoral models were being used in many developed and developing countries to study the effect of changes in either wage rates, profits or indirect taxes on the prices of various sectors of the economy. This is because any change in wages, profits or indirect taxes in any or a set of products, will not only change the costs and prices of the sectors where such changes have taken place, but will also change the costs and prices of other sectors through their input output linkages. These changes are by no means uniform across all the sectors. Leontief, using the Input Output table of the American economy, 1939, has shown the changes in prices of various sectors as a result of arbitrary 10% changes separately in wages, profits and indirect taxes in agricultural and non-agricultural groups of sectors. However, the extent of changes in sectoral prices will depend on to what extent any changes in wages are offset by changes in profits.

In the context of the Indian Economy, price effects of commodity taxation were studied by **Radhakrishnan and Rangarajan (1967)** using the Input Output table of the Indian Economy for 1965 as presented in **Rudra & Manne study (1965).** Specifically, they studied the price effects of commodity taxation proposed in 1967-68 Central budget relating to items such as Coffee & Tea, Cigarettes, Footwear, Petroleum, Plastics, Man-made Fibres, Rubber Manufactures, etc.

Rangarajan, Sah & Reddy (1981) later used the 66X66 Input Output table as prepared by **Planning Commission (1973)** to study the impact of hike in prices of coal & petroleum products on the other sectors of the economy. This study was conducted by clamping the prices of certain commodities at a particular level as a policy measure, to study the impact of prices in the rest of the sectors. Thus, in this study alternative scenarios of impact in prices were worked out taking into consideration no change in railway prices, electricity prices etc., as they are controlled by the Government.

In India prices in a large number of sectors are controlled by the Government. For increasing the resource potential of the Government, the administered prices of many public sectors are changed from time to time. **Gupta and Srinivasan (1984)** have used the 89X89 Input Output table that was developed for the preparation of the **Sixth Plan of Planning Commission (1981)** to study the impact on sectoral prices as a result of changes in administered prices in certain public sectors. The study has also estimated the net additions to public sector resources.

Sarkar and Panda (1986) have constructed a Computable General Equilibrium (CGE) model for India to study the Quantity-Price-Money interactions. This is a very comprehensive model. It considers income by different income classes. The income levels along with sectoral prices determine the sectoral consumption patterns using Linear Expenditure System. Consumption in turn affects output levels. One added advantage of this model unlike the above-mentioned ones is that consumption is treated as endogenous variables. The model is used to study the effect of alternative tax expenditure policies on the various endogenous variables including prices, consumption etc.

Olav Bjerkholt (1986) has discussed the uses of Input Output models in national budgeting policies and in medium term planning in the Norwegian economy. The latest version of this model is called MODIS IV. This model covers about 2000 exogenous variables and about 5000 endogenous variables. The results are obtained as impact coefficients which indicate the effect on the price indices of private consumption, government consumption, gross investment, and gross domestic product due to changes in import prices, wage rates, and selected indirect taxes and subsidies.

Leontief in one of his recent papers (1985) has described a revised version of the basic input output price model to analyse the effect of the new wave of technological changes in the US economy in the next two decades. For this he has extended prices, wages and non-wage income relationships by introducing an additional parameter of rate of return on capital within the framework of a given technology, or, rather a given set of technologies. Unlike the earlier models, this is a linear programming model. The idea is to obtain an optimal combination of old and new technologies in each sector with the objective of minimizing the cost-of-living index, given the overall rate of interest, money wage rates of different sectors and types, and current and capital coefficient matrices for new and old technologies. The sectoral prices are treated as variables.

The **EMPOV II** model by **Dhar, Rao & Goel (1992)** is developed to obtain relevant set of commodity and factor prices which would help to match given targets of supply of given vector of basic needs with demands. The sectoral consumption function estimating market determined consumption through price and income elasticities have been included as endogenous variables in the model. Further, instead of assuming a fixed level for the average propensity to save (APS), both upper and lower limits have been specified for APS, so that the actual value can be anywhere within this range. Prices of imported items have not been considered separately in this model. Only a single set of commodity prices, same for all income groups, and, uniform factor prices, same for all the sectors, have been considered. The model is solved for the national economy as a whole, considering foreign trade as given.

03 : Regional & Multi-regional Studies.

The possible use of input output models to study regional growth also brought about some modifications of the original input output model.

The inter-regional model has been found to be helpful for regional and inter-regional analysis, particularly in big economics, although the difficulty of obtaining elaborate data may have very much restricted its use in many instances.

As we see, there can be three types of structural relations in an economy. They are across sectors (inter-sectoral), ie, current input coefficients, across time (inter-temporal), ie, capital coefficients, and, across regions (inter-regional) ie., inter-regional and inter-sectoral coefficients.

Both consistency and optimising types of models can be developed for the required multisectoral types of analysis.

Construction of models with a regional breakup of the national economy dates back to as early as 1951 when **Walter Isard (1951)** presented his model on " Inter-regional and Regional Input Output Analysis". Such inter-regional input output models (IRIO) require data not only on inter-sectoral transactions as in a national model, but each transaction has to be further broken down into its region of origin. Japan is one of the few countries where such IRIO models are constructed regularly under **MITI (1970)** for every five years since 1960. **Ooserhaven (1981)** has developed a five reoion IRIO model of the Dutch economy.

The difficulty of getting detailed data for IRIO models has led to research on inter-regional commodity flows, and gave birth to the development of Multi-regional Input Output models (MRIO).Pioneering work on the development of MRIO models has been done by **Chenery (1953)**, for the Italian economy, & **Moses (1955)**, and **Polenske (1980)** for the US economy.

Leontief (1953) developed a 'balanced regional' model considering 'local' and 'national' groups of sectors. Later, **Leontief and Hoffenberg (1961)** used this model to study the effect, of a compensated 20% cut in armament expenditure, on the output and employment of the various regions of the US economy. **Leontief and Strout (1963)** developed a gravity' model for multi-regional analysis. This model treats trade variables as a function of both demand and supply simultaneously, and calculates gravity coefficients instead of using trade coefficients as in the Chenery/Moses models.

All the models discussed above may be considered as multi-regional consistency models where trading relations are assumed to be fixed.

Construction of multi-regional programming models with a provision for varying trading relations started in late 50s. Such programming models were developed either for a single sector in a multi-regional framework as in **Henderson (1958)** for Coal industry or in a multi-regional multi-sectoral framework as in **Moses (1960)**.

A number of multi-regional models - consistency as well as single and multi-sectoral optimising models - were constructed for the Indian economy. The construction of such models was taken up in the early 1960s. **Ghosh (1965)** prepared a single sector optimising model for the cement industry of India to study the efficiency of inter-regional flows of that sector. The first multi-regional input output model for the Indian economy was constructed by **Dhar (1965)** for the year 1953-54. This table was used by **Dhar,Venning and Berry (1966)** and **Ghosh (1967)** to obtain certain interesting projections for various regions of the Indian economy. The same table was also used by **Dhar (1972, 1973)** to study the implications for income leakages (1972) and to study the nature of spatial clusters (1973) of the Indian economy.

Bhatia (1961) made a study to delineate an inter-industry, inter-regional and inter-temporal linear programming model of technological transformation of the Indian economy from traditional one to a modern one. Narain **Das and Sardesai (1967)** developed a four region five sector model to test a methodology for determining the optimal location of industries in various regions of India by minimising transport costs. **Mathur and Hashim (1967)** have experimented with a four region twenty three sector model to obtain optimum levels of production and trading by minimising transport costs. **Mathur (1972)** has also developed a dynamic model with five regions and twenty seven sectors for India and offered various alternative solutions under different assumptions regarding trade balance and output growth rate constraints by minimising the transport costs.

For two decades after that there was a lull in the area of construction of multi-regional models for the Indian economy.This was partly due to the large magnitude of work involved in the construction of such an elaborate model and partly due to emphasis on centralised planning framework.

Dhar and Rao [1983] have developed an EMPOV Model to analyse the feasibility of a basic needs strategy of growth for tackling the problems of poverty and unemployment. An empirical analysis of this model was conducted for the regional economy of Bangalore district of Karnataka State of India. Subsequently, the above EMPOV Model was extended in terms of the methodology used, by the same authors along with Goel [1988] and an empirical analysis was conducted for the Indian economy for the Eighth and the Ninth plans simultaneously.

Of late there is a growing realisation that important tasks such as the reduction of unemployment and poverty cannot be taken up at the aggregative national level alone and there is a need for decentralised planning which necessitates construction of multi-regional models. Recently **Dhar (1989)** has constructed a multi-regional fixed trading model for five regions and thirteen sectors to obtain consistent projections for each of the sectors of each region for the Eighth plan period (1989-90 to 1994-95) for India.

Dhar, Goel and Rao (1993) have constructed a Multi-regional Model for India 2000 AD. This model, unlike past attempts on construction of multi-regional models, specifically deals with the problems of availability of basic needs in all the regions simultaneously by reducing the existing inequality between regions in per capita aggregate household consumption levels. An appropriate consumption target is fixed and GDP or value added is maximised to achieve a more equitable distribution of income across the regions. The model also helps in studying the trading and thereby, transport implications for each region.

The innovation of electronic computing machines made possible the essentially simple but tediously long calculations involved in using input output model for projection purposes. Computer softwares have been developed to assist easy operations of these models. IBM software "ECONIO" is one such very useful software. Both student and commercial versions of this software is available.

04 : Structure of the Basic Input Output Model

The conventional form of the Leontief model deals with current production and is, therefore, concerned only with static analysis. The transactions in his model may be described in the two sector case, as follows:

$$X_1 - X_{11} - X_{12} = f_1 \qquad \text{-- (1)}$$

$$X_2 - X_{21} - X_{22} = f_2 \qquad \text{-- (2)}$$

Where X_1 and X_2 are the outputs of sector 1 and 2 respectively, x_{11} is the output of sector 1 absorbed in the production of sector 1 again (similarly, X_{12}, X_{21}, & X_{22} may be explained, the first subscript denoting the producing sector and second subscript, the consuming sector) and f_1 and f_2 are the final demands of sector 1 and 2 respectively.

The final demands include items like sectoral domestic consumption, Government's current consumption, the net capital formation, replacement and net additions to stocks and, exports net of imports. In an open model final demand items are exogenously determined.

We can now define input coefficients, a_{11}, a_{12}, a_{21}, and a_{22}, as :

$a_{11} = x_{11}/x_1$;
$a_{12} = x_{12}/x_2$;
$a_{21} = x_{21}/x_1$; and,
$a_{22} = x_{22}/x_2$.

and, substituting the above relations to (1) and (2) we get

$$X_1 - a_{11}.X_1 - a_{12}.X_2 = f_1 \quad \ldots (3)$$

$$X_2 - a_{21}X_1 - a_{22}.X_2 = f_2 \quad \ldots (4)$$

in matrix notation this becomes.

$$\begin{bmatrix} X_1 \\ X_2 \end{bmatrix} - \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} . \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = \begin{bmatrix} f_1 \\ f_2 \end{bmatrix}$$

$$\text{or,} \quad X - a. X = f \quad \ldots (5)$$

$$\text{or,} \quad X = (1-a)^{-1}. f \quad \ldots (6)$$

$$\text{or,} \quad X = A.F. \quad \ldots (7)$$

Where, the elements of matrix A are the elements of matrix $(I-a)^{-1}$.

From relation (7) it can be seen that it is possible to make projections of future levels of outputs for given values of final demands.

On expanding equation 6 we get,

$$X = (1 + a + a^2 + a^3 + s^4 + \ldots\ldots\infty) . f$$

$$= f + a.f + (a^2.f + a^3.f + \ldots \infty).f \quad \ldots (8)$$

$$= X + Y + Z \quad \text{(say)}$$

Where,

$X = f =$ final demand ;

$Y = a.f =$ direct inputs of f ; and,

$Z = (a^2 + a^3 + \ldots\ldots \infty) \cdot f =$ all indirect inputs of inputs of f, and so on.

Equation (8) shows that for an increase of final demand by an amount f, f has to be first produced to meet the additional demand for f.

In the second stage, a.f outputs also have to be produced to meet the input demands of production of f.

Then, in the subsequent stages, all the indirect input demands in the form of inputs of inputs, and so on (ie, $a^2.f + a^3.f + \ldots \infty$) have also to be supplied.

One may thus distinguish three levels of demands in an input output model.

- production equivalent of additional final demand;
- direct inputs of additional final demands; and,
- indirect input demands of inputs of inputs etc.

Input Output Multipliers:

The notion of input output multipliers rests upon the difference between the initial effect of an exogenous (final demand) change and the total effects of that change. The total effects include direct and indirect effects (with household sector as exogenous), or, direct, indirect and induced effects (with household sector as endogenous). The former is called simple multipliers, and the later as total multipliers.

These multipliers may measure either changes in output, incomes or employments due to changes in final demands of each of the sectors of the economy.

The concept of multipliers are useful in policy analysis. It helps to select appropriate mix of policies which is optimal from the point of view of achieving given development objectives.

The multiplier is estimated as follows:

$$O_j = \sum_i A_{ij} \quad \ldots(9)$$

where,

O_j = multiplier, sector j .

A_{ij} = Elements of inverse matrix.

This model is generalized for more than two sectors.

It is generally convenient to discuss the detailed transactions of an economy, presenting them in four inter-related quadrants as shown below.

The transactions in an input output model starts with first presenting all items of **aggregate demands**, namely, private and public consumption, investment, and, exports net of imports. These transactions are shown in **quadrant I.** Sectoral break-ups of each item of aggregate demand of quadrant I is shown in **quadrant II.** In input output terminology these are called **sectoral final demands.**

In an input output model **intermediate input demands** which constitute as one of the most important components of total demand for any product are shown explicitly in the model. All intermediate input transactions and the technological coefficients (current input coefficients) worked out from these transactions are shown in **quadrant III.** These coefficients are shown in the form of a square matrix of dimension, $n \times n$; n, being the number of sectors into which all the economic activities are grouped together. In an input output model, therefore, the entries in each row shows all the inputs delivered to all the other sectors including itself, together with those of the deliveries for all final demands, and, both intermediate and final demands together sum to gross output level of each sector.

Quadrant IV shows the uses of all primary inputs like labour, capital etc. in the production process, which constitute value added of each sector. Each column, therefore, shows all current inputs consumed in each sector together with value added including depreciation and all indirect taxes, and they again sum up to gross output level for each sector.

In an input output transactions, therefore, column sums and the row sums are always equal. Therefore, such a model has the advantages of a double entry data system.

<u>Intermediate inputs.</u> Current input co-efficient matrix, and transactions. $x_{ij} = a_{ij} \cdot X_j$ for, $i,j = 1,\ldots,n$. **(Quadrant III)**	<u>Sectoral final demands.</u> $FD_i = C_i+G_i+I_i+E_i-M_i$ for each $i = 1,\ldots,n$. n= no. of sectors of the economy. **(Quadrant II)**
<u>Primary inputs.</u> Sectoral Value-added. $V_j = X_j - \sum_i x_{ij}$ $Y = \sum_j V_j$ **(Quadrant IV)**	<u>Macro-economic balances.</u> $Y = C+G+I+E-M$ **(Quadrant I)**

Treatment of Factor Inputs.

The inputs mentioned so far are intermediate inputs, and are quite distinct from the primary inputs of land, labour, capital and organisation. These primary inputs are generally placed as a row vector below the coefficient matrix, and the future levels of these primary inputs (mainly labour) are determined from the relation, primary inputs/outputs, after the output levels are projected.

Limitations.

Leontief considered input coefficients as engineering coefficients, and, therefore, fixed as long as technology used is unchanged. The model, therefore, implicitly assumes,

a) constant returns to scale, and,
b) absence of substitution between inputs.

The scope for using an input output model for projection purposes is thus limited because it is based on the above rigid assumptions.

It should be thus kept in mind that the results based on such rigid assumptions may sometimes be misleading.

05 : A 6 x 6 Input Output Model of India, 1983-4 at 1983-4 prices.

Table 1 presents the sample of a six sector input output model for the Indian economy for 1983-4, at 1983-4 prices, condensed from the 60 sector IO model prepared by CSO, Govt. of India (1990).

The six sectors are :

1. Agriculture & allied Products.
2. Basic Goods (Minerals, Chemicals, Metals & Non-metallic Mineral Products).
3. Capital Goods (Machinery & Construction).
4. Intermediate Goods (Jute Textiles, Plastics, Rubber, Paints, Petroleum Products).
5. Consumer Goods (Food Products, Textiles, Paper, Leather and Wood Products, Drugs & Miscellaneous industrial products).
6. All Services.

TABLE 1 : INTER-INDUSTRIAL TRANSACTIONS MATRIX, 1983-84. (6 x 6 Sectors)

(In Rs. Crores at 83-84 prices)

	1	2	3	4	5	6	ST
1.Agr. & Allied	16778	77	914	505	12884	2708	33866
2.Basic Goods.	3900	10687	10449	7210	3620	1946	37812
3.Capital Goods	1324	1002	3276	113	524	4104	10343
4.Int. Goods	685	2553	1768	1621	1963	3787	12377
5.Cons. Goods	1394	536	1753	860	11596	5546	21685
6.All Services	3851	4836	6367	2069	8114	14549	39786
7.Sub Tot	27932	19691	24527	12378	38701	32640	155869
8.Ind. Tax	-931	1900	3270	1938	3646	2783	12606
9.GVA at fc	67134	13742	15295	3046	15906	70704	185827
10.Gr.Output	94135	35333	43092	17362	58253	106127	354302
TOT SUPPLY	95307	42989	46045	19002	61233	107401	371977

Table 1 (Contd.)

	PFCE	GFCE	GFCF	CIS	EXP	IMP	OUTPUT
1.Agr. & Allied	57945	55	206	1950	1285	1172	94135
2.Basic Goods.	1635	543	432	-115	2679	7656	35333
3.Capital Goods	1410	2111	30961	399	821	2953	43092
4.Int. Goods	3463	437	1368	617	740	1640	17362
5.Cons. Goods	30398	1217	481	3014	4440	2980	58253
6.All Services	46132	16056	1739	0	3689	1274	106127
7.Sub Tot	140983	20419	35187	5865	13654	17675	354302
8.Ind. Tax	4915	723	3132	0	-514	0	20862
9.GVA at fc	0	0	0	0	0	0	185827
10.TOTAL	145898	21142	38319	5865	13140	17675	

Source : Input Output Transactions of the Indian Economy, CSO, Planning Commission, GOI, New Delhi, 1990.

The various items of sectoral final demand items generally considered in an input output model are as under :

PFCF = Private Final Consumption Expenditure.

This includes all current consumption expenditures of households covering Agricultural (Perishable and Non-perishable), Industrial (Durable and Non-durables), and Services (Trade, Transport, Banking, Insurance, Government, Real estate, Personal etc.) sectors.

GFCF = Government Final Consumption Expenditure.

This includes all government current consumption (purchases) expenditures including all current as well as capital expenditures of Defence services.

GFCF = Gross Fixed Capital Formation.

This includes all expenditures on additions to physical capital (Machinery & Construction) of both public (excluding those for Defence services) and private sectors, Residential Buildings, and all Depreciation/Replacement expenditures.

The expenditure on Inventory Investment (Changes in Stocks) is shown separately as this item covers only Fixed Investments.

CIS = Changes in Stocks.

Changes in Stocks or Inventory is an important component of demand as this helps to avoid fluctuations in consumption, production and trading activities. The level of inventory changes with the level of activities in an economy.

This measures the differences between the closing and the opening stocks of each activity.

EXP = Exports.

This covers all sales of goods and services to foreign countries valued at **fob** (free on boat).

IMP = Imports.

This includes all purchases of goods and services from foreign countries valued at **cif** (cost, insurance and freight)

Table 2 presents data on forward linkage co-efficients. The entries in each row explain the pattern of deliveries of inputs as proportions of total available supply of each sector. This will give an idea about the magnitude and direction of pattern of deliveries of total supply of the

TABLE 2 : FORWARD LINKAGE COEFFICIENTS, Aij / (Xi+Mi).
(per Rs.1000 of supply)

	1	2	3	4	5	6	ST
1.Agr. & Allied	176.0	0.8	9.6	5.3	135.2	28.4	355.3
2.Basic Goods.	90.7	248.6	243.1	167.7	84.2	45.3	879.6
3.Capital Goods	28.8	21.8	71.1	2.5	11.4	89.1	224.7
4.Int. Goods	36.0	134.4	93.0	85.3	103.3	199.3	651.3
5.Cons. Goods	22.8	8.8	28.6	14.0	189.4	90.6	354.2
6.All Services	35.9	45.0	59.3	19.3	75.5	135.5	370.5

Table 2 (Contd.)

	PFCE	GFCE	GFCF	CIS	EXP	IMP	GO
1.Agr. & Allied	608.0	0.6	2.2	20.5	13.4	12.3	987.7
2.Basic Goods.	38.1	12.6	10.1	- 2.6	62.2	178.1	821.9
3.Capital Goods	30.6	45.9	672.4	8.7	17.7	64.1	935.9
4.Int. Goods	182.2	23.0	72.0	32.5	39.0	86.3	913.7
5.Cons. Goods	496.4	19.9	7.9	49.2	72.4	48.7	951.3
6.All Services	429.5	149.5	16.2	0	34.3	11.9	988.1

products of each sector. Thus, for example, these data indicate that 17.6% of total supply of Agriculture and Allied Products sector are used in the same sector as self inputs in the form of Seed, Feed, Wastage etc. Nearly 61% of supply, on the other hand, is used for private consumption, and so on and so forth. Each of the other entries in **Table 2** can similarly be explained.

The data of **Table 3** indicate backward linkage coefficients. The entries in any one column indicate the current input structure for the production of that sector. For example, column 3 indicate the input structure of Capital Goods sector. The Capital Goods sector needs, among other inputs, Rs.0.24 worth of current inputs from the basic goods sector to produce Re.1 of output of Capital Goods.

The column for the sub total indicate the proportionate uses of different current inputs in the entire production process of all the activities of the economy.

The entries in the columns for the final demand items indicate the proportionate uses of different products in each of these uses. For example, Private Consumption of Agriculture & Allied Activities constitute as high as 40% of total, All Services 32% of total and consumption of industrial goods about 21% of total, the balance goes as indirect taxes and consumption expenditures on other industrial goods. Similarly, the patterns of sectoral composition of other final demand items, namely, investment, exports and imports can be observed from the data of the same **Table 3.**

Table 3 : BACKWARD LINKAGE COEFFICIENTS, Aij / Xj.
(per Rs.1000 of output)

	1	2	3	4	5	6	ST
1.Agr. & Allied	178.2	2.2	21.2	29.1	221.2	25.5	95.6
2.Basic Goods.	41.4	302.5	242.5	415.3	62.1	18.3	106.7
3.Capital Goods	14.1	28.4	76.0	6.5	9.0	38.7	29.2
4.Int. Goods	7.3	72.3	41.0	93.4	33.7	35.7	34.9
5.Cons. Goods	14.8	15.2	40.7	49.5	199.1	52.3	61.2
6.All Services	40.9	136.9	147.8	119.2	139.3	137.1	112.3
7.Sub Tot	296.7	557.5	569.2	713.0	664.4	307.6	439.9
8.Ind. Tax	- 9.9	53.8	75.9	111.6	62.6	26.2	35.6
9.GVA	713.2	388.7	354.9	175.4	273.0	666.2	524.5
10.Gr.Output	1000	1000	1000	1000	1000	1000	1000

Table 3 (Contd.)

	FFCE	GFCE	GFCF	CIS	EXP	IMP
1.Agr. & Allied	397.2	2.6	5.4	332.5	97.8	66.3
2.Basic Goods.	11.2	25.7	11.3	-19.5	203.9	433.1
3.Capital Goods	9.7	99.9	808.0	68.0	62.5	167.1
4.Int. Goods	23.7	20.7	35.7	105.2	56.3	92.8
5.Cons. Goods	208.3	57.6	12.6	513.8	337.9	168.6
6.All Services	316.2	759.5	45.4	0	280.7	72.1
7.Sub Tot	966.3	966.0	918.4	1000	1039.1	1000
8.Ind. Tax	33.7	34.0	81.6	0	-39.1	0
9.GVA	0	0	0	0	0	0
10.Gr.Output	1000	1000	1000	1000	1000	1000

Table 4 presents the data on inverse matrix of (I-a). The data of each column of this matrix indicates the vector of outputs of each of the sectors that will be necessary to be produced in order to support unit final demand in the respective sectors. These demands as mentioned above are the sum of the following three demand components :

a. The given final demand of the given sector;
b. Vector of direct inputs of this sector; and,
c. Further rounds of indirect input demands of the direct inputs as in b above.

Table 4 : MATRIX (I-A) INVERSE
(per Rs.1000 of Final Demand)

	1	2	3	4	5	6
1.Agr. & Allied	1230.3	36.0	67.7	84.6	358.2	65.4
2.Basic Goods.	101.6	1553.9	468.0	742.6	202.5	100.0
3.Capital Goods	26.0	61.9	1111.7	46.5	36.2	56.0
4.Int. Goods	23.8	140.5	103.3	1181.3	79.1	62.0
5.Cons. Goods	33.2	60.7	92.3	111.3	1283.6	88.7
6.All Services	87.5	288.0	297.0	310.9	273.4	1210.3
Total	1502.4	2141.0	2140.0	2477.2	2233.0	1582.4

Let us demonstrate the direct and indirect effects of additional final demand of Rs.1000 of consumer goods. The data is presented in the table below:

Sectors Total	Final demand	Direct Inputs	Indirect Inputs	Total (Dir+Ind)
1.Agr. & all.358	-	221.2	137.0	358.2
2.Basic goods 203	-	62.1	140.4	202.5
3.Cap.goods 36	-	9.0	27.2	36.2
4.Int.goods 79	-	33.7	45.4	79.1
5.Cons goods 1284	1000	199.1	84.5	1283.6
6.All Serv. 273	-	139.3	134.1	273.4
Total		664.4	568.6	2233.0

The data on direct inputs are obtained from **Table 3**, total from **Table 4**, and the indirect was obtained as a residue. These results indicate the uses of an input output model.

It is almost impossible to get an idea of the indirect input demands of any increase in final demands in any one sector without using an input output model. Input output model can easily be used to find out the combined effects of simultaneous increases in final demands in several sectors. Under real life situations, demands increase simultaneously in several sectors at any particular point in time. Input output models are, therefore, used by many countries for demand forecasting of their product/s.

In planning, when development objectives change, their impact on demand can easily be worked out using this model. If, suppose gradual shifts take place in demands from defence to civilian goods all over the world, it will bring about tremendous change in the composition of demands for various commodities. Such problems have to be studied within an inter-sectoral framework.

The column sum of the inverse matrix provide data on multipliers. These are output multipliers. It is possible to estimate value-added or employment levels of these outputs using appropriate norms. One may then be able to estimate income or employment multipliers.

It may be observed from the data of **Table 4** that there are wide differences in the values of output multipliers across sectors. Intermediate goods sector has the highest multiplier of a value of 2.48 per Re. of Final demand of that sector, followed by consumer goods sector with a value of 2.23. Agriculture and Allied Product has the lowest value of only 1.5. Wide differences are thus observed in the values of multipliers.

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