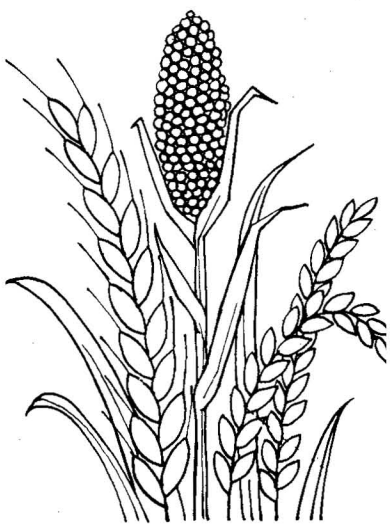
Vol XIX
No. 2

APRIL-
JUNE
1964

ISSN 0019-5014

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS



INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

NOTES

AN APPLICATION OF INPUT-OUTPUT ANALYSIS TO INDIAN AGRICULTURE*

One possible use of input-output analysis is to study the effect of price change in one sector on the price level of the other sectors of the economy. In this Note, the effect of a given percentage change in factor payments of the agricultural sector on the prices of outputs of different sectors of economy has been studied through the aggregated inter-industry table prepared by the Indian Statistical Institute for 1953-54. The 36 x 36 transaction table of 1953-54 is aggregated into five sectors, namely: (1) Agriculture including plantations; (2) Animal Husbandry; (3) Mining; (4) Manufacturing and (5) Tertiary. An examination of the transaction flows of the sectors showed that the flows from 'plantations' to other sectors except sector 12, 'large scale food manufacturing' are small. Consequently, 'plantations' which cover crops like tea, coffee, is added to 'agriculture' sector in this study. All the manufacturing sectors, large and small, are aggregated into one single sector as 'manufacturing.' Similarly, all the trade and services sectors are aggregated into one sector as 'tertiary.'

Suppose that the economy can be divided into distinguishable sectors or industries. Let X_{ij} be the amount of output of ith industry absorbed as input jth industry. Let a_{ij} be the input-output coefficient. Then the values of levels of production of different industries, $X_1, X_2, \ldots . X_n$ that should be obtained to reach desired levels of final demand can be determined from the equation:

$X = (I—A)^{-1} y$ where

X is the n × 1 matrix of outputs $X_1, X_2, \ldots X_n$.

I is the identity matrix of n × n.

A is the n × n matrix of input-output coefficients.

Y is the n × 1 matrix of final demands of different sectors.

For given changes in the prices of primary factors of different industries, the indices of change in the output prices of different industries can be determined. Let f_j be the change in the price of primary factor of jth industry, pj be the index of change in output price of jth sector or industry and Vj be the labour or primary input in jth industry. The set of equations that give the values of p's can be written in matrix form as

$P = (I—A')^{-1} \quad DF = [(1—A)^{-1}]' DF.$

where

A′ is the transpose of the n × n matrix of input-output coefficients

P is n × 1 matrix of prices $p_1 p_2 \ldots\ldots p_n$

D is n × n diagonal matrix with $V_1/X_1 \ldots\ldots V_n/X_n$ as elements and

F is n × 1 matrix of $f_1 f_2 \ldots f_n$.

* The material presented in this paper is part of the Thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Agricultural Economics in the Graduate College of University of Illinois, 1963.

Application

The transactions between the five sectors into which the thirty-six sectors of the inter-industry table of 1953-54 have been aggregated, are given in Table I below:

TABLE I—INTER-INDUSTRY TRANSACTIONS IN INDIAN ECONOMY 1953-1954

(Rs. crores)

Producing Sectors	Purchasing Sectors					Total inter-mediate use	Final demand	Total output
	Agri-culture	Animal husban-dry	Min-ing	Manu-factur-ing	Ter-tiary			
Agriculture	259.81	808.95	--	617.34	68.0	1754.10	3559.40	5313.50
Animal Husbandry ..	838.07	0.95	0.47	235.47	135.17	1210.13	931.46	2141.59
Mining	2.74	0.10	9.10	79.79	109.18	200.91	*	183.70
Manufacturing	95.66	56.13	8.86	673.01	517.08	1350.74	2185.52	3536.26
Tertiary	14.28	66.08	4.39	369.21	426.57	880.53	4877.98	5758.51
Total Material Input ..	1210.56	932.21	22.82	1974.82	1256.00	5396.41		16933.56
Value added	4102.94	1209.38	160.88	1561.44	4502.51			
Total Output	5313.50	2141.59	183.70	3536.26	5758.51			16933.56

* Negative.

From the above table, the input-output coefficients can be worked out. The calculation of input-output coefficients for agriculture is illustrated below :

	Inputs to agriculture (Rs. crores)	Proportion to total output of agriculture
Agriculture	259.81	.048896
Animal Husbandry	838.07	.157725
Mining	2.74	.000516
Manufacturing	95.66	.018003
Tertiary	14.28	.002687
Total Output of Agriculture	5313.50	

Table II below gives the input-output coefficients.

TABLE II—INPUT-OUTPUT COEFFICIENTS 1953-54

	Agriculture	Animal Husbandry	Mining	Manufac-turing	Tertiary
Agriculture	.048896	.377733	.0	.174574	.011809
Animal Husbandry	.157725	.000444	.002558	.066587	.023473
Mining	.000516	.000047	.049537	.022563	.018960
Manufacturing	.018003	.026209	.048231	.190317	.089794
Tertiary	.002687	.030856	.023898	.104407	.074076

It will thus be noted from Table II that only about 23 per cent of total output in agriculture comes as input from other sectors including agriculture. From agriculture itself, only 4.9 per cent comes as input. The flow from animal husbandry forms the largest item of input to agriculture. Similarly, the flow from agriculture constitutes the largest input to animal husbandry. Animal husbandry sector depends to the extent of 44 per cent of its output on all sectors for its inputs. More than 50 per cent of output in manufacturing comes as input from all sectors. The mining sector output largely depends on the autonomous input. Looking horizontally at the observations in Table I, we see that only 33 per cent of output of agriculture is consumed by the interacting sectors. Major part of the output of agriculture is thus seen to be used as household consumption. On the other hand, 56 per cent of output in the animal husbandry sector is consumed by all the five sectors.

The inverse of the matrix (I—A) is given in Table III. It is obtained as a power series expansion and approximated upto fifth power of A.

TABLE III—INVERSE OF (I—A) MATRIX

1.128586	.435045	.016702	.284929	.052855
.180327	1.072924	.010506	.132009	.042220
.001622	.002267	1.054411	.033044	.024843
.032273	.048975	.082645	1.263921	.125681
.012714	.041573	.035124	.148134	1.096167

A knowledge of this inverse matrix is required in many applications of input-output analysis.

The equations giving the values of output in terms of final demand are:-

$X_1 = 1.128586\ Y_1 + .435045\ Y_2 + .016702\ Y_3 + .284929\ Y_4 + .052855\ Y_5$

$X_2 = .180327\ Y_1 + 1.072924\ Y_2 + .010506\ Y_3 + .132009\ Y_4 + .042220\ Y_5$

$X_3 = .001622\ Y_1 + .002267\ Y_2 + 1.054411\ Y_3 + .033044\ Y_4 + .024843\ Y_5$

$X_4 = .032273\ Y_1 + .048975\ Y_2 + .082645\ Y_3 + 1.263921\ Y_4 + .125681\ Y_5$

$X_5 = .012714\ Y_1 + .041573\ Y_2 + .035124\ Y_3 + .148134\ Y_4 + 1.096167\ Y_5$

Suppose that there is 10 per cent increase in factor payments of the agricultural sector, then the indices of change in output prices of different sectors, resulting from this increase, can be determined through the formula given earlier. In our case, $n=5$, $f_1=1.1$, $f_2=1.0$, $f_3=1.0$, $f_4=1.0$, $f_5=1.0$,

$$\frac{V_1}{X_1} = \frac{4102.94}{5313.50} = .772173$$

$$\frac{V_2}{X_2} = \frac{1209.38}{2141.59} = .564711$$

$$\frac{V_3}{X_3} = \frac{160.88}{183.70} = .875776$$

$$\frac{V_4}{X_4} = \frac{1561.44}{3536.26} = .441552$$

$$\frac{V_5}{X_5} = \frac{4502.51}{5758.51} = .781888$$

Agriculture
Animal Husbandry
Mining
Manufacturing
Tertiary

$$\begin{bmatrix} p_1 \\ p_2 \\ p_3 \\ p_4 \\ p_5 \end{bmatrix} = \text{Transpose of the matrix given in Table III.} \times \begin{bmatrix} .772173 & 0 & 0 & 0 & 0 \\ 0 & .564711 & 0 & 0 & 0 \\ 0 & 0 & .875776 & 0 & 0 \\ 0 & 0 & 0 & .441552 & 0 \\ 0 & 0 & 0 & 0 & .781888 \end{bmatrix} \begin{bmatrix} 1.1 \\ 1.0 \\ 1.0 \\ 1.0 \\ 1.0 \end{bmatrix}$$

$$\begin{bmatrix} p_1 \\ p_2 \\ p_3 \\ p_4 \\ p_5 \end{bmatrix} = \begin{bmatrix} 1.0860 \\ 1.0315 \\ 1.0075 \\ 1.0194 \\ 1.0031 \end{bmatrix}$$

If 10 per cent increase in factor payments of animal husbandry sector occurs, the indices of changes in output prices of different sectors are given by :

$$p_1 = 1.0091$$
$$p_2 = 1.0585$$
$$p_3 = 1.0067$$
$$p_4 = 1.0048$$
$$p_5 = 1.0013$$

Thus, an increase of 10 per cent in factor payments of agricultural sector will cause an increase of 8.6 per cent in the price of output of the same sector, 3.2 per cent in the price of output of animal husbandry and 1.9 per cent in manufacturing. The prices of outputs in the other two sectors 'mining' and 'tertiary' do not seem to change. On the other hand, a 10 per cent increase in factor payments in the animal husbandry sector seems to cause 5.9 per cent increase in the price of output of the same sector, causing little or no change in the prices of outputs of other sectors.

Agriculture, plantations, animal husbandry including forestry and fishery are considered as individual sectors in the input-output table prepared so far. The

importance of the agricultural sector in the Indian economy needs no emphasis. Thus, from the agricultural planning point of view, the input-output table should distinguish as many sectors as possible within the agricultural sector and include or distinguish such other sectors which provide inputs to or processed products from agriculture. The classification of sectors for use in the construction of the table is, of course, conditioned by availability of adequate and reliable statistical information. The coverage of statistical data and their availability is at present more widespread and reliable in the agricultural sector than in animal husbandry, forestry and fisheries. As such, more production activities within the agricultural sector need to be included in the construction of any input-output table that might be attempted now and which is to be bigger than the present one. For instance, the production activities that might be considered are production of major food crops, commercial crops like cotton, sugarcane and oilseeds and plantation crops like tea, coffee and rubber.

A. V. K. SASTRI*

A SIMPLE QUANTITATIVE MODEL FOR THE ALLOCATION OF LAND TO MORE THAN ONE CROPS IN RELATION TO SIZE†

It has been observed that the allocation of cultivated land for different crops varies with the size of the total land holding,[1] and in particular that cash crop acreage forms a larger proportion of the total land holding in the larger holdings than in the smaller holdings. In general the net profitability per acre is greater in the case of cash crops than in the case of food crops. A number of explanations can be put forward for this difference in the allocation-pattern in such a situation. Here the allocation of land between two main groups of crops only, namely, cash crops and food crops is considered.

(1) Domestic demand for food crops both for consumption, kind wages, etc., wherever wages are given in kind and there are other kind transactions, has to be taken into account while studying the allocation-pattern of land between cash crops and food crops.

Domestic demand for food crops which is for consumption and which forms the major part of the total domestic demand is proportional to the family size and not to the size of the holding. To the extent, per capita (or per consumption unit) land is larger in a holding, a greater percentage of the land becomes available for profit-cultivation (cultivation for non-consumption purposes). Again a large holder may be less averse to monetary transactions and hence he may not mind going in for the most profitable crop allocation even though it may entail his buying some food crops for his own use. Similarly, a small holder may go in for more kind wage and other non-monetary transactions than a larger holder and hence

* Assistant Economic and Statistical Adviser, Directorate of Economics and Statistics, Ministry of Food and Agriculture, Government of India, New Delhi.

† The author is very grateful to the referee for his helpful comments.

1. Sapre, Seminar paper entitled "Changes in the Cropping Pattern of Some Farmers in Two Irrigated Villages in the Nasik District during 1940-60," Gokhale Institute of Politics and Economics, Poona 4, 1961.