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AN INTERINDUSTRY ANALYSIS OF STRUCTURAL INTERDEPENDENCE IN PARAMBIKULAM ALIYAR PROJECT REGION*

Interindustry Model, otherwise called Input-Output Model, considers general economic equilibrium empirically by a study of interdependence of the production plans of industries in a region. Since its first application by Leontief in 1936 for the United States economy, it has been utilized by economists to measure the extent of structural interdependence for different countries/regions. In the present study the Parambikulam Aliyar Project region was selected for analysing the sectoral interdependencies as a means of identifying the problems of and bottlenecks for economic development of the region, using interindustry model. It was hypothesized that though sectoral interdependency could be observed in the region, there is probably a need to strengthen their interdependencies through investment planning on specified priorities.

The major objective of this paper is to analyse the inter-sectoral relationship between the different sectors in the study area and to identify the key sector of the region.

METHODOLOGY

The present attempt was a part of the integrated study undertaken by the Department of Agricultural Economics, Tamil Nadu Agricultural University, to identify the determinants of development and problems therein in the Parambikulam Aliyar Project region which consists of four taluks, namely, Pollachi, Udumalpet, Palladam and Dharapuram in Coimbatore district of Tamil Nadu.

Identification of Sectors

A list of firms operating in the study area was obtained from the Assistant Director of Industries and Commerce, Coimbatore and the firms were then grouped into different sectors, each sector being defined by the homogeneity of the products produced/services rendered. Apart from agriculture and livestock sectors, the following eight endogenous sectors¹ were identified in the study region: Agricultural services, Textiles, Safety matches, Sugar mill, Agricultural machinery, Other manufacturing, Chemicals and Miscellaneous. The final demand sectors considered for analysis were the Household, Government, Exports, Gross inventory accumulation and Gross private capital formation and dummy or primary input sectors considered were the Household, Government, Imports, Gross inventory depletion and Unallocated inputs.²

* This paper forms part of the M.Sc. (Ag.) dissertation submitted by the senior author to the Tamil Nadu Agricultural University, Coimbatore, in 1976.

1. For an excellent and simple description of the various concepts used in the interindustry model, the reader may refer to Ananda S. Rao and David J. Allee: An Application of Inter-industry Analysis to San Benito County, California, Giannini Foundation Research Report No. 278, University of California, California, 1964.

2. For a definition of these sectors, see the Appendix.

Sampling Procedure

A total sample size of 90 was fixed for all the endogenous sectors considered for the study. The data for Agriculture and Livestock sectors were collected from a random sample of 30 cultivators and 20 livestock farmers respectively. The 40 more respondents contemplated in the study were distributed among the other eight sectors as indicated below. In the Textiles sector, apart from yarn and ready-made garments producing firms, there were as many as 1,200 firms producing banians in the study area. If these 1,200 firms were also considered for sampling purposes by proportionate sampling, then nearly 90 per cent of the sample would be covered by the Textiles sector itself. So in order to include such firms which would represent the other sectors also, the 1,200 banian producing firms were considered as a single unit and grouped under Textiles and the data were collected for the single unit from the South Indian Hosiery Producers' Association. Again to represent the Sugar mill sector, the only firm that produced sugar in the region was also included in the sample. The rest of the sample size, namely 38, was distributed among the other sectors based on the proportion of total number of registered firms under each sector in the region to the total number of firms.³

The data needed to fit the interindustry model were obtained through personal interviews from the selected respondents, with the help of a pre-tested schedule. The data collected relate to the agricultural year 1974-75.

Tool of Analysis

To find out the extent of structural interdependence among the different producing sectors of the region, the input-output (interindustry) model of open and static type was used.⁴ With the help of the interdependence coefficients obtained from this model, it becomes possible to trace the impact of the final demand vectors on the output structure of the economy.

Estimation of Total Outputs

The total value of output for the sectors Agriculture, Livestock and Agricultural services were obtained by blowing the sample values to the gross cropped area, number of milch cattle and the total number of Agricultural services firms respectively in the region.

In the case of Textiles, the total value of output was obtained, first by getting the total value of output of the firms other than banian producing firms by multiplying the total number of such firms in the region by their sample value and then adding to it the total value of output of banian producing firms. For all the other sectors the total output was obtained by blowing the sample figures to the total number of registered firms in each sector in the region.

3. Barring Agriculture and Livestock sectors, the percentage of sample firms to total firms in each sector was around 40.

4. For a simple description of the input-output model, the reader may refer Rao and Allee: *op. cit.* or W. H. Miernyk: *The Elements of Input-Output Analysis*, Random House Inc., New York, 1967.

Preparation of the Transactions Table

The transactions table was prepared with the transactions measured at the gross sale price received by the producers (producers' price) for their products. In filling the cells of the transactions table mostly the 'sales' figures were considered. However, in certain cases where sales from one endogenous to another endogenous sector could not be easily made out, the purchase quantities of the latter from the former were utilized for filling up that cell after valuating the quantities at the sale price of the producer. And the difference between the value at purchasers' price and producers' price was accounted for, as expenses under 'Unallocated inputs'. In order to balance the total output and total outlay of each sector, the difference between the total receipts and total expenses of a sector was considered as its net profit/loss and included under 'Unallocated inputs'.

Estimation of Final Demand Vectors

In estimating the final demand quantities of different sectors, no secondary data were utilized. Sales made to places outside the region constituted 'exports' and sales made to the Government, at any level, *i.e.*, local, State and Central, were included under 'Government'. The possibility of re-entry of exports in the region and 'resale' by the Government to the local household had been ignored. Flow of investment goods, *i.e.*, goods whose utility were of a long-term in nature, were directed to 'Gross private capital formation' whatever sector would have acquired them, while the amount of inventories accumulated constituted 'Gross inventory accumulation'. Sales made by a sector to the local household constituted the household component. However, in certain cases where this 'sales to household' component could not be directly estimated because of sales to other endogenous sectors getting mixed up with it (mainly due to inadequate information provided) it was obtained as a residual after allotting the required output to those endogenous sectors based on their purchase quantities. Kind wages paid by Agriculture to labour were treated as sales to the household and the wages for labour were imputed at 'current' prices and included with the cash payments made to the labour.

Limitations of the Data

1. The data needed to develop the interindustry transactions matrix were obtained from the respondents' memory in the case of Agriculture and Livestock sectors and with respect to a few small firms (in other sectors) where detailed accounts were not kept. The result of the study must be interpreted subjected to limitation of recall and respondents' bias.
2. The firms involved in 'servicing' functions like wholesaling, retailing, banking, etc., had not been included and hence to that extent the study did not cover the economy in its entirety.
3. No secondary data were used in the study and only primary data were used even to estimate the final demand vectors for the different sectors.

RESULTS AND DISCUSSION

The interindustry model for the Parambikulam Aliyar Project region is presented in this paper as a series of three matrices, as is the general case in presenting interindustry model, namely, (i) the Transactions Matrix, (ii) the Direct Requirements Matrix, and (iii) the Direct and Indirect Requirements Matrix (Interdependence Coefficients Matrix).

(i) *The Transactions Matrix*

The Interindustry Transactions Matrix for the Parambikulam Aliyar Project region for the year 1974-75 is presented in Table I. The Transactions Matrix was simply a basic accounting system reflecting the rupee flow of products and services within the economy. The row entries would reflect the sales made by the row sectors to different column sectors and its column entries would reflect the purchases by the sector listed at the top from the sectors listed under producing. The total sales made to different endogenous sectors constituted the intermediate demand and sales to final demand sectors constituted the final demand for the particular sector. For example, by looking at Table I, it could be said that Agriculture had sold Rs. 894.709 lakhs worth of goods to itself, Rs. 885.677 lakhs worth of goods to Livestock and so on. Viewing columnwise, it could be seen that Agriculture had consumed Rs. 894.709 lakhs worth of its own goods, purchased Rs. 250.800 lakhs worth of goods from Livestock and so on. The total intermediate demand for Agriculture was Rs. 2,358.381 lakhs which constituted 13.55 per cent of its total output. Similar interpretations could be made for other sectors also. The total outlay and total output values for each endogenous sector would be equal since taxes, wages and salaries, profits and retained earnings or losses had been accounted for as purchases by each producing sector. However, a final demand and its corresponding primary input sector need not have to balance. For example, the local household had received Rs. 5,412.767 lakhs as income in the form of wages and salaries while it had spent Rs. 6,623.601 lakhs for consumption. There was a large deficit between the income received and expenditure by the household and this could be due to the fact that the income received by the household did not include that part of the income received from the unorganized sectors and from the firms involved in 'servicing' functions like wholesaling, retailing, banking, etc., while purchases made included the purchase made by all the households, inclusive of those employed in the unorganized and services sectors. Also a part of the deficit might represent dis-saving on the part of the household.

It would be seen from Table I that in general the sectors in the region were not quite dependent on one another as could be evidenced by the zero entries in many of the cells. For a more meaningful discussion, the direct requirement coefficients and interdependence coefficients were calculated and presented in Tables II and III.

TABLE I—TRANSACTIONS MATRIX: INTERINDUSTRY FLOW OF GOODS IN PARAMBIKULAM ALIYAR PROJECT REGION, 1974-75

(value in lakhs of rupees)

Purchasing Producing	Intermediate demand										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Agriculture	Livestock	Agricultural services	Textiles	Safety matches	Sugar mill	Agricultural machinery	Other manufacturing	Chemicals	Miscellaneous	
1. Agriculture	894.709	885.677	220.374	213.270	0	144.351	0	0	0	0	0
2. Livestock	250.800	0	0	0	0	0	0	0	0	0	0
3. Agricultural services ..	26.269	17.778	0	20.520	0	0	0	0	0	0	0.240
4. Textiles	0	0	0	522.371	0	0	0	0	0	0	0
5. Safety matches	0	0	0	0	0	0	0	0	0	0	0
6. Sugar mill	0	0	0	0	0	22.00	0	0	0	0	0
7. Agricultural machinery ..	0	0	0	0	0	0	0	0	0	0	0
8. Other manufacturing ..	0	0	0	0	0	0	0.303	0	0	0	0
9. Chemicals	5.187	0	0	0	0	0	0	0	0	0	0
10. Miscellaneous	0	0	0	0	0	0	0	0	0.262	0	0
11. Household	4,430.334	303.217	9.964	586.569	4.095	70.000	2.565	2.626	1.835	1.562	1.694
12. Government	199.415	0	8.766	194.591	15.802	22.818	1.798	0.736	1.205	1.694	29.619
13. Imports	4,794.985	361.292	0	1,692.825	11.458	70.482	28.199	14.071	19.010	29.619	10.141
14. Gross inventory depletion ..	0	0	12.451	0	0	0	0.221	0	0.243	10.141	7.529
15. Unallocated inputs	6,801.280	449.207	37.397	742.233	5.820	87.154	4.139	6.570	6.643	7.529	50.785
16. Total outlay	17,402.979	2,017.171	288.952	3,972.379	37.175	416.805	37.225	24.003	29.198	50.785	

(Contd.)

TABLE I (Concl'd.)

(value in lakhs of rupees)

Purchasing Producing	Final demand						Gross private capital forma- tion	Gross inventory accumulation	Total output
	Household	Government	Exports	(14)	(15)	(16)			
(1)	(12)	(13)	(14)	(14)	(15)	(16)	(17)		
1. Agriculture	4,994.645	1,002.386	9,047.567	9,047.567	0	0	17,402.979		
2. Livestock	1,403.376	0	362.995	362.995	0	0	2,017.171		
3. Agricultural services ..	114.780	0	109.365	109.365	0	0	288.952		
4. Textiles	100.769	0	3,300.309	3,300.309	48.930	0	3,972.379		
5. Safety matches	8.819	0	28.356	28.356	0	0	37.175		
6. Sugar mill	0	197.956	196.849	196.849	0	0	416.805		
7. Agricultural machinery ..	0	0	29.383	29.383	0	7.842	37.225		
8. Other manufacturing ..	0.994	0.396	22.198	22.198	0	0.112	24.003		
9. Chemicals	0.125	15.375	8.511	8.511	0	0	29.198		
10. Miscellaneous	0.093	0	50.430	50.430	0	0	50.785		
11. Household	0	0	0	0	0	0	5,412.767		
12. Government	0	0	0	0	0	0	446.825		
13. Imports	0	0	0	0	0	0	5,021.941		
14. Gross inventory depletion ..	0	0	0	0	0	0	23.056		
15. Unallocated inputs	0	0	0	0	0	0	10,447.972		
16. Total outlay	6,623.601	1,216.113	13,155.963	13,155.963	48.930	7.954	43,529.233		

TABLE III—INTERDEPENDENCE COEFFICIENTS—DIRECT AND INDIRECT REQUIREMENTS MATRIX

Purchasing Producing (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Agricul- ture	Live- stock	Agricul- tural services	Textiles	Safety matches	Sugar mill	Agricul- tural machinery	Other manufac- turing	Chemical- icals	Miscel- laneous
Agriculture	0.0707	0	0.3886	0	0	*	0.0050
Livestock	0.0010	0	0.0056	0	0	*	0.0001
Agricultural services	0.0061	0	0.0006	0	0	*	0.0059
Textiles	1.1514	0	0	0	0	0	0
Safety matches	0	1.0000	0	0	0	0	0
Sugar mill	0	0	1.0557	0	0	0	0
Agricultural machinery	0	0	0	1.0000	0	0	0
Other manufacturing	0	0	0	0.0082	1.0000	0	0
Chemicals	*	0	0.0001	0	0	1.0000	*
Miscellaneous	0	0	*	0	0	0.0091	1.0000
Total	1.2292	1.0000	1.4506	1.0082	1.0000	1.0091	1.0110

* Negligible.

(ii) *The Direct Requirements Matrix*

The direct requirement coefficients or technical coefficients as they are generally referred to, represent the amount of inputs required from each sector to produce one rupee worth of output of a given sector.⁵ These coefficients for the different sectors are shown in Table II. For example, reading down the column of Textiles in Table II, it could be found that in order to produce one rupee worth of output, it required Re. 0.05 worth of goods from Agriculture, Re. 0.005 worth of goods from Agricultural services and Re. 0.13 worth of goods from itself. Further it had paid Re. 0.15 to labour (Household), Re. 0.05 to Government as taxes and Re. 0.43 for imported inputs.

It could be seen from Table II that Agricultural machinery (0.7621), Other manufacturing (0.5862), Chemicals (0.6565) and Miscellaneous (0.7287) sectors purchased over one half of their inputs from firms outside the study area. This high level of dependence on imports would result in a substantial leakage of money from the region if these sectors suddenly realised increased demand for their products.

In general, the sectors in the region were dependent only on a few other sectors, that too only to a limited extent, for their direct input requirements. This was due to the fact that these sectors were not interlinked with each other and there was no relationship between the products produced by them.

(iii) *The Interdependence Coefficients Matrix*

The interdependence coefficients represent both the direct and indirect requirements of each sector's output required to meet a rupee worth of additional final demand for the products of a particular sector. These coefficients are presented in Table III. Reading down the column of Agriculture from Table III, it could be said that for the Agriculture sector to deliver an additional one rupee worth of its output to final demand, holding the final demand for the products of other sectors at the initial level, the direct and indirect requirements of this sector would be Re. 1.0628 from itself, Re. 0.0153 from Livestock, Re. 0.0017 from Agricultural services and Re. 0.0003 from Miscellaneous. To that extent the output of these sectors would be increased. Thus the total output increase of all the sectors would be 1.0801. Similar interpretations could be made for other sectors also.

A perusal of Table III would reveal that there existed a low level of interdependency as among the different sectors in the Parambikulam Aliyar Project region as indicated by the zero entries and relatively small/negligible

5. The technical coefficients are normally arrived at by dividing each column entry in the transactions table of a particular sector by the total outlay. However, in the present study the total gross adjusted outlay was considered for calculating the technical coefficients because the gross inventory depletion only represented the previous year's output which had been sold during the current year and did not form a cost component. Hence it was deducted from the total outlay to get the total adjusted outlay. This methodology was suggested by Miernyk: *op. cit.*

values in several cells of Table III.⁶ This situation was found in the study area because the region defined was so small that support and supply sectors did not exist and the region was principally a rural area which had little manufacturing activity.⁷ The significance of low level of interdependence as evidenced here, would be the dampening of exogenous economic stimuli through leakage, a condition that could not be easily corrected but must be considered in evaluating alternative development strategies.

Selection of Target Sectors for the Development of the Region

The main use of the interindustry model is that it helps to identify the key sector of the region. Directing the investment policies towards the development of the key sector would bring about a rapid development of the region as a whole. The criterion used in selecting the target sector is the high value of the output multiplier. The total output increase in all the sectors due to one rupee increase in the final demand of a given sector is called the output multiplier for that sector and it can be obtained by summing the interdependence coefficients for the sector. The output multipliers for different sectors in the study area are shown in Table IV.

TABLE IV—OUTPUT MULTIPLIERS AND WEIGHTED OUTPUT MULTIPLIERS

Sr. No.	Name of the sector	Multiplier value	Weighted output multiplier (lakhs of rupees)
1.	Agriculture	1.0801	1,879.738
2.	Livestock	1.4906	300.688
3.	Agricultural services	1.8609	51.453
4.	Textiles	1.2292	488.304
5.	Safety matches	1.0000	3.718
6.	Sugar mill	1.4506	60.463
7.	Agricultural machinery	1.0082	3.731
8.	Other manufacturing	1.0000	2.400
9.	Chemicals	1.0091	2.922
10.	Miscellaneous	1.0110	4.109

It could be seen from Table IV that Agricultural services had the highest output multiplier (1.8609) followed by Livestock (1.4906), Sugar mill (1.4506) and Textiles (1.2292). The output multiplier for Agricultural services was 1.8609 indicating that if this sector delivered one rupee worth of additional goods to final demand, the total output of the region would increase by Rs. 1.8609. Similar interpretations could be made for others also. Using the criterion discussed earlier, programmes or policies directed towards increasing the level of activity of Agricultural services, Livestock and Sugar mill sectors, perhaps by increasing their exports, might yield the greatest increase in the rupee output in Parambikulam Aliyar Project region.

6. This view was further confirmed by calculating the indirect requirements and ratio of indirect to direct requirements for each sector and the results showed that the indirect requirements were very negligible indicative of low amount of interdependency.

7. Low amount of inter-sectoral interdependency in the rural areas was also observed by G. Caruthers, K. Mitchell and T. D. Williams: *An Interindustry Model of the Economy of North Central New Mexico*, Agricultural Experiment Research Station Report No. 237, New Mexico State University, New Mexico, 1972 and Bill R. Miller and Leon H. Langley, Jr., "Suggested Sectors for Input-Output Models for Rural Areas", *American Journal of Agricultural Economics*, Vol. 56, No. 2, May 1974, pp. 450-452.

However, to evaluate the total impact of each sector in the level of economic activity within the region, it would be more useful to weight the multipliers.⁸

The weighted multipliers (given in Table IV) were calculated by multiplying each sector's multiplier by 10 per cent of the concerned sector's adjusted total outlay in 1974-75. These multipliers would reflect the increase in the region's total gross output given a 10 per cent increase in the final demand for that sector's output. If the weighted output multipliers were considered, then the Agriculture sector stood first. The advantage of using these multipliers for evaluation is that they would give some evidence of the relative importance of each of the sectors to the total regional output.

Though the output multipliers for the Agricultural services, Livestock and Sugar mill sectors were high, the high value of the weighted output multiplier for Agriculture showed the importance of this sector in the economy of the region. Since the study area was a project area, the development of Agriculture would contribute to the development of the region. Consistent with what the results revealed, the development of Agriculture would also help in the development of Agricultural services, Livestock, Sugar mill and Textiles sectors (because of their dependence on Agriculture) which in turn had relatively high output multipliers. So it could be concluded that high investment priorities in Agriculture could help to improve the economy of the area.

CONCLUSION

The above analysis revealed that there existed a low amount of interdependency as among the different sectors in the Parambikulam Aliyar Project region and that several of the sectors depended, from sources outside the region, for most of their raw material requirements. Such a situation was not favourable for the region concerned because most of the income flowing into the region by way of exports would be passed on to other regions because it had to draw most of its raw material requirements from them, thus scarcely benefiting the region. This situation prevailed in the study region because the area was primarily a rural area with agriculture and agro-based industries flourishing and had little manufacturing activities and also due to the smallness of the region defined. Establishment of support and supply industries to cater to the raw material requirements of different sectors would go a long way to strengthen the sectoral interdependency in the region. The key sector for the region was identified to be Agriculture and hence the investment policies directed towards the development of this sector would help in improving the economy of the region, through its linkage effects on Agricultural services, Livestock, Sugar mill and Textiles sectors of the region.

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8. The concept of weighted multiplier had been utilized by Carruthers *et al.*: *op. cit.*, in identifying the key sector for the North Central New Mexico. The authors had multiplied the output multipliers for the different sectors by 10 per cent of the concerned sector's output to get the weighted output multipliers.

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APPENDIX

DEFINITION OF SECTORS

(i) *Endogenous Sectors*

(1) *Agriculture*: All farms in the region that produced agricultural commodities formed this sector. Since bullocks were mainly utilized for agricultural operations, they were classified under this sector.

(2) *Livestock*: All livestock farmers who produced milk were included. Since poultry keeping, sheep rearing and other livestock activities were very negligible, only cattle excluding bullocks were included under this sector.

(3) *Agricultural services*: All firms that undertook processing of agricultural products like cotton ginning, decortication and extraction of oil from groundnut and rice hulling were considered under this sector.

(4) *Textiles*: Firms producing yarn, banians and ready-made garments were included.

(5) *Safety matches*: Included firms producing safety matches.

(6) *Sugar mill*: Since there were no *gur* or Khandsari manufacturing units, firms producing sugar were considered.

(7) *Agricultural machinery*: Firms dealing with the production of agricultural tools and implements like levellers, ploughs, etc., and agricultural machinery like sugarcane crushers, electric motors and pumpsets were grouped under this sector.

(8) *Other manufacturing*: Firms producing trunk boxes, household articles, hammerbits, cycle parts, bumper rods, bolts and nuts, upholstery and other iron and steel goods were grouped under this sector.

(9) *Chemicals*: Firms producing shell lime, calcium oxide, gypsum, pesticides, fertilizer and other chemicals were grouped under this sector.

(10) *Miscellaneous*: All firms which were not covered under the above nine sectors were grouped under this sector. Firms producing paper, cover bags, polythene bags, polythene tubes and covers, washing soaps were included.

(ii) *Final Demand Sectors*

(1) *Household*: This represented the local people in the region who were the ultimate consumers of finished goods and services of the different sectors.

(2) *Government*: Purchases made by all levels (local, State and Central) of Government from the different sectors comprised this sector.

(3) *Exports*: The amount of goods and services sold outside the region by the different producing sectors constituted exports.

(4) *Gross inventory accumulation*: Represented the amount of inventories accumulated in a sector during the period covered.

(5) *Gross private capital formation*: Purchase by all buyers for the replacement of or additions to plant and equipment constituted the gross private capital formation.

(iii) *Dummy Sectors*

(1) *Household*: Represented payments made to the local household in the region in the form of wages, salaries and other perquisites, by different sectors for utilizing the services of labour.

(2) *Government*: The amount of taxes paid by the different sectors to all levels of Government was included in the group.

(3) *Imports*: Imports represented the amount of raw materials and other inputs purchased from outside the region by endogenous sectors.

(4) *Gross inventory depletion*: This represented the amount of previously accumulated stocks of finished products which were sold to different sectors during the period under study.

(5) *Unallocated inputs*: This included the payments made by the endogenous sectors in the form of rent, depreciation, interest, repairs and maintenance and other expenditures. Profit was also included under this sector.