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AN INTERINDUSTRIAL ANALYSIS OF THE TRANSPORTATION SECTOR

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I Output of the Transportation Sector and Interindustrial Input-Output Table

A variety of analyses of interindustrial composition based on an interindustrial input-output table have come to be made and utilized later in various fields of industry and their practicability has been more and more appreciated, the fact of which, we believe, can well be ascribed to the corroborative usefulness provided by such analyses. Now, the subject matter of this paper conforms with the corroborative purpose of these interindustrial analyses. In other words, it is attempted in this paper, by picking up the transportation sector for our analysis, to show clearly in what relative position in the interindustrial composition the transportation sector should be found by using concrete numerical figures based on the table of interindustrial input-output for the year 1960[1].

Now, one of the most important considerations we must take into account when the interindustrial analysis with respect to the transportation sector is to be made, is the fact that the output of the freight transportation service is being carried on in company with the commodity circulation in the same manner as in the case of commercial margin. Consequently it is possible that two different kinds of interindustrial input-output tables come to be prepared, depending on how the above-mentioned facts are reflected. The reason is because the different ways of dealing with the commercial sector and the transportation sector naturally lead to two different evaluations. Therefore it is necessary to have first of all a clear knowledge of the relationship among the way of handling the commercial sector and transportation sector and the above-

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1) As for interindustrial analyses in connection with the transportation group so far published, see "Special Edition of Interindustrial Analysis related with Transportation Group", comp. by Statistics Research Section of Transportation Ministry Secretariat in *Transportation Survey Monthly*, Vol. 7, No. 1, January 1965; Hiroyuki Yamada, "Interindustrial Model of Fare Fluctuation", *Transportation Survey Monthly*, Vol. 8, No. 4, 1966. The present authors' intention is to supplement the comparatively unsatisfactory parts of studies in the past.

mentioned different evaluation of prices.

Producers' Price and Purchasers' Price

Needless to say, an interindustrial input-output table shows all the transactions carried on among sectors which include both goods-producing sectors and service sectors during a given period. But it is possible to estimate the value of such transactions between two sectors either by the producers' price or by the purchasers' price. Here, by "the producers' price" is meant the price at the time when a commodity is to part from the producers' hand, which is sometimes called the "price of shipment" or "FOB" price. Contrarily, what is called "the purchasers' price" is the price paid by the purchaser when he buys a commodity, which is sometimes called the "franco price" or "CIF" price. Consequently in the latter is included the commercial margin and the freightage, and hense the following relationships are established between the former and the latter prices.

Turnover at producers' price+commercial margin+freightage
=turnover at purchasers' price

Accordingly, the problem of which one of these two price estimates to use is none other than the problem how to handle the commercial margin and the freightage——ordinarily these two are put together and called the "circulation margin".

Now, to begin with, we shall proceed to see how they are handled in the table of producers' price evaluation. In this case the sales of each industry, except for commerce and transportation sectors, is evaluated by the producers' price which is exclusive of the circulation margin. This means, as far as the vertical line in the interindustrial input-output table is concerned, that input commodities for each sector which includes commerce and transportation are handled as if they were purchased directly from the producers at their price of shipment, even though they are in reality purchased from some firms at prices inclusive of the commercial margin and freightage. Alternatively, by thinking that the commercial margins and freightage which are expended as a result of such transactions are the value of the commercial service and transportation service purchased from the commercial sector or transportation sector, if they are entered at the point where the vertical line crosses the lateral line of the commerce and transportation sector, then the value expended and the value produced come to match in this case, and the circulation margin can be handled without causing any contradictions. In this case, the sum of the sales of the commercial service and transportation service to each industry to be represented in the lateral line of the commerce sector and transportation sector means the sum of the commercial margin and the sum of the freightage, each of which has to be added at the time when each industry makes purchases of the various kinds of input commodities. Therefore the sum of the transportation cost which accrues whenever one sector makes purchases of some input commodities from other sectors is explicitly shown in the table of producers' price evaluation. Now, keeping in mind the above-mentioned view of one economic system which is composed of four sectors consisting of agriculture, manufacture, transportation and household, we can show the following interindustrial table based on the producers' prices as a hypothetical example.

Table of Producers' Price Evaluation

From \ To	Agriculture	Manufacture	Transportation	Household	Total
Agriculture	20	40	10	30	100
Manufacture	30	160	20	90	300
Transportation	(Agr 3) (Man6) 9	(8) (16) 24	(1) (1) 2	(6) (9) 15	50
Household	41	76	18		135
Total	100	300	50	135	

According to this table, the sum (9) of the feightage (3) necessitated by the flow of commodities from branch of agriculture to its own sector (20) and the freightage (6) necessitated by the flow of commodities from manufacture to agriculture (30) put together is represented as the sum of sales from the transportation sector to the agriculture sector, i. e. the input of the transportation service to the agricultural sector.

On the other hand, in the case of the purchasers' price table, the evaluation is made at the prices inclusive of the commercial margin and freightage. For this reason, as far as the only item of freightage is to be taken into consideration, the input of the transportation service to each industry, in other words the lateral line which represents the sale from the transportation sector to each industry, comes to be blank. Consequently if the table of the purchasers' price evaluation, which corresponds to the hypothetical example given above, is to be shown in conformity with the composition of the interindustrial input-output table for the year 1960, the following table is obtainable[2].

2) From the interindustrial input-output table prepared in 1960 the following tables are provided: table of producers' price evaluation: table of purchasers' price evaluation: freight charge table and commercial margin table which link together the aforementioned two tables as additional tables ...... See *Working Report of 1950 Interindustrial Analysis Table,* comp. by Statistics Standard Bureau of Administrative Management Agency, 1966.

Table of Purchasers' Price Evaluation

From \ To	Agri-culture	Manu-facture	Trans-portation	House-hold	Total demand	Out-put	Freight-age	Total supply
Agriculture	23	48	11	36	118	100	18	118
Manufacture	36	176	21	99	332	300	32	332
Transporta-tion	–	–	–	–	–			
Household	41	76	18		135			
Total	100	300	50	135				

In this way it is seen that the total of the figures on the lateral line for each industry, i. e. the total demand which is defined as an intermediate demand plus the final demand, comes to exceed the value of output by freightage, and it comes to be balanced with the total supply, which is defined as the value of output plus freightage. The lateral line for the transportation sector is left blank and, accordingly, the total of the figures on the vertical line for each sector shows the value of output in the equivalent amount represented on the table of evaluation of producers' prices.

In this connection, if a table of freightage is prepared based on the difference between the evaluation table of the producers' price and that of the purchasers' price, it can be shown as follows:

Table of Freight Evaluation

	Agriculture	Manufacture	Transpor-tation	Household	Total
Agriculture	3	8	1	6	18
Manufacture	6	16	1	9	32
Total	9	24	2	15	50

This table shows the freightage necessitated by the transactions between different sectors. As has been made clear already, the total of the figures on each vertical line represents the input from the transportation sector to the respective sector. On the other hand, the total of figures on each lateral line of the same table represents the sum of sales of the transportation service necessitated by the sales of input commodities, which may be called the transportation proceeds according to each item[3].

3) It is possible to make an advanced interindustrial analysis with respect to the transportation sector by making use of the table of freight charges. An analysis with this point in mind has been taken up in Hiroyuki Yamada, "Transportation Input and Interindustrial Analysis", *Keizai Ronso*, Vol. 101, No. 1, January 1968.

Preparation of a Consolidated Table

We think that the foregoing explanations have given a clear idea of how the freightage should be handled in the interindustrial input-output table and how the relationships between the producers' price and the purchasers' price should be understood.

Now, then, based on the foregoing considerations, we shall proceed to give an interindustrial input-output analysis primarily concerned with the field of the transportation industry, using the input-output table of the Japanese economy for the year of 1960. It is no longer necessary to say that the table of the producers' price evaluation is very useful for that purpose. The reason is mainly because the lateral line of the transportation sector on the table of the purchasers' price evaluation is left blank, with the exception of the case of passenger transportation, and, even if it may be possible to make an analysis of the input structure of the transportation sector itself, it is impossible to make an analysis of the demand structure; and also because it is impossible to make an analysis of the effects of propagation (or repercussion) caused by the input of the freight transportation service on the other industries[4].

Thus, we shall now demonstrate how to make a comparative analysis of the structural characteristics of each of the varied means of transportation based on the table of the producers' price evaluation prepared by further dividing one big transporation industry group into a number of smaller sub-sections. The reason is partly because a comparatively complete study on this subject matter has never been made before in the field of analysis of interindustrial input-output with respect to the transportation sector, and partly because we are forced to take up this subject matter only on account of the limited space available for this paper[5]. Now, for the above-mentioned purpose of analysis we shall turn to a Simplified Consolidated Table (composed of a 35-industry-group) prepared by us from a Standard Table (composed of a 153-industry-group), which has already been officially published. The way in which the classified kinds of industry are arranged in our 35-group-consolidated table is explained in the following chart by comparing it with the way adopted in the 153-industry-group table.

4) Besides the table of producers' price evaluation can reflect the commodity input-structure in a more exact way. Hence it is more suitable for the analysis of propagation-effects based on the inverse matrix coefficients.

5) However, in chapter IV, we shall take up our "3-group model" in order to clarify the complicated interindustrial relationships among the commodity producting sector, service sector and transportation sector. For a detailed explanation of our 3-group model, see Hiroyuki Yamada & Takeo Ihara, "Three-industry-group Model in Input-Output Analysis", *Keizai Ronso*, Vol. 98, No. 5, November 1966; and "Input-Output Analysis of Interregional Repercussion", in *Papers and Proceedings*, Vol. III, 1967.

Comparison of Two Industrial Groups according to a 35-industry-group and a 153-industry-group

Kind/Section	35-group	153-group
Agriculture, forestry & fishery	1	1-16
Coal, petroleum & natural gas	2	17, 20, 21
Metal & other industry	3	18, 19, 22-24
Food	4	25-37
Textile	5	38-55
Lumber, furniture, pulp & paper	6	56-61
Printing & publication	7	62
Leather & rubber	8	63-65
Chemical industry	9	66-78
Petroleum & coal products	10	79-81
Cement, clay & stone	11	82-86
Iron	12	87-94
Metal products	13	95-100
Electricity	14	101-110
Precision & others	15	118-121
Transportation machinery	16	111-117
Construction & civil engineering	17	122-126
Electric power	18	127
City-gas	19	128
Water	20	129
Unclassifiable	21	153
Wholesale	22	130
Retail	23	131
Banking	24	132
Insurance	25	133
Real estate	26	134, 135
Service given to other works	27	149
Service given to individuals	28	145-148, 150-152
National railway	29	136
Private electric trains & other surface passengers	30	137, 142
Surface freight	31	138
Water transportation	32	139, 140
Airlines	33	141
Warehouse	34	143
Communication	35	144

II Analysis using the Interindustrial Input-Output Table

To begin with, using an interindustrial consolidated table, we shall attempt to give a clear idea of the structural characteristics of the transportation sector in comparison with the commodity producing sector and other service sectors.

Sales Structure

If we check the interindustrial input-output table along its lateral line, we can clearly visualize the channel through which each sector has made sales of products, i. e. "the sales structure" of each sector. Table II-1 shows the various computed component ratios relatively occupied by each sub-section of the transportation sector with respect to the intermediate demand and the final demand for the first thing and further breakdown ratios of the final demand to be occupied by such items as non-household consumption expenditures, private consumption expenditures, government consumption expenditures, total domestic fixed capital formation, stock net increase and export.

This table shows that the ratio of final demand to total demand for the transportation sector is 41.4 %, being a little in excess of the 40.4 % of the commodity producing sector and considerably lower than the 73.5 % of the service sector. Of course this is only applicable to the average, and if we take a view along each sub-division of the transportation sector, we can find wide distributions to a great extent varying from 65.8 % for private electric trains and surface passengers at the top of the list to 16.9 % for communications at the bottom. Consequently, if we are to compute a final demand ratio for the six sub-sections put together, with the exception of communications, among all the seven sub-sections which belong to the transportation sector, we get 46.2 %, which is almost comparable to the 46.8 % average of the whole industry. Among all of them, those of which the final demand ratio exceeds the intermediate demand ratio are only two sections, showing 65.8 % for private electric trains and surface passengers and 53.5 % for airlines. Water transportation (42.0 %), national railway (40.8 %), warehouse (31.3 %) and surface freight (28.9 %) are all found to be lower than the intermediate demand ratio.

Lastly, let us examine the component ratios of the final demand according to each sub-section. Of the sum of the final demand for the transportation sector (¥712,800 million), 68.2 % is occupied by private consumption expenditures, 20.4 % by export, and the weight of government consumption expenditures is 7.2 %, which is considerably lower than the weight of the service sector. Remarkably characteristic is the fact that

Table II-1 Market Structure of the Transportation Sector

(%)

Item / Sub-section & Sector	Ratio of intermediate demand	Ratio of final demand	Component Ratios of Final Demand					
			Non-household consumption expenditure	Private consumption expenditure	Government consumption expenditure	Total domestic fixed capital formation	Stock net increase	Export
National railway	59.2	40.8	1.8	77.9	7.8	2.7	1.2	8.6
Private electric trains & surface passengers	34.2	65.8	0.0	92.9	6.5	0.1	0.0	0.4
Surface freight	71.1	28.9	6.2	51.1	1.0	9.8	4.3	27.6
Water transportation	58.0	42.0	0.8	18.7	1.4	0.3	0.3	78.0
Airlines	46.5	53.5	1.0	48.1	13.4	–	–	37.6
Warehouse	68.7	31.3	5.4	62.7	0.4	5.5	4.2	21.9
Communication	83.1	16.9	0.3	53.5	35.8	–	–	10.4
Transportation sector	58.6	41.4	1.4	68.2	7.2	1.9	1.0	20.4
Service sector	26.5	73.5	7.0	60.0	27.2	2.9	0.4	2.6
Commodity producing sector	59.6	40.4	4.1	39.2	1.0	38.4	5.4	11.9
Average of whole industry	53.2	46.8	4.9	46.6	9.1	26.3	3.7	9.5

among the component ratios of the transportation sector the weight occupied both by the private consumption expenditures and by export respectively is considerably high in percentage in comparison with other items[6]. Of these two, in the case of the former the particular items that are connected with the transport of passengers, such as private electric trains and other surface passengers (92.9 %) and national railway (77.9 %), show an exceptionally heavier weight in private consumption expenditures. And in the case of export, it is noticeable that with the two exceptions of the national railway and private electric trains and other surface passengers out of the seven sub-sections of transportation sector, all of them show a considerably greater percentage than 9.5 % of the average of the whole industry, and especially water transportation, being 78.0 %, ranks first in the order among all the seven sub-sections.

Purchases Structure

Now, if the interindustrial input-output table is examined along its vertical line, we can clearly visualize the channel through which each section has made purchases when the respective section executes production, i. e. "the purchase structure" of each section. Table II–2 shows the various computed intermediate input ratios and value added ratios with respect to each section for the first item, and the further breakdown ratios of value added to be occupied by such items as non-household consumption expenditures, earned income, operating surplus, capital depreciation allowances, indirect tax and subsidy.

Taking up the ratio of value added to begin with, the 76.7 % of the service sector ranks first, then the 67.9 % the transportation sector and finally the 34.1 % of the commodity production sector, which is the lowest. When the value added ratios for the seven sub-sections which belong to the transportation sector are taken up, all of them are found to show a greater percentage than the 44.3 % average for the whole industry, and among them, with the exception of the 46.5 % for airlines, all the rest show a greater percentage than the intermediate input ratio. Again, if the average ratio of value added for six sub-sections, excluding communications, is to be computed, 65.3 % is obtainable, which is lower than the 67.9 % average for the whole transportation sector by nearly 2.6 %, but this is because the value added ratio for communications is extremely high (81.8 %), having a considerably great weight in the whole transportation sector.

Now, let us see about the component ratios of value added for each sub-section of the transportation sector. Of the total sum of value added

6) The value of final demand for the commodity producing sector and service sector is ¥11,998,400 million and ¥5,455,000 million respectively.

Table II-2 Input Structure of the Transportation Sector

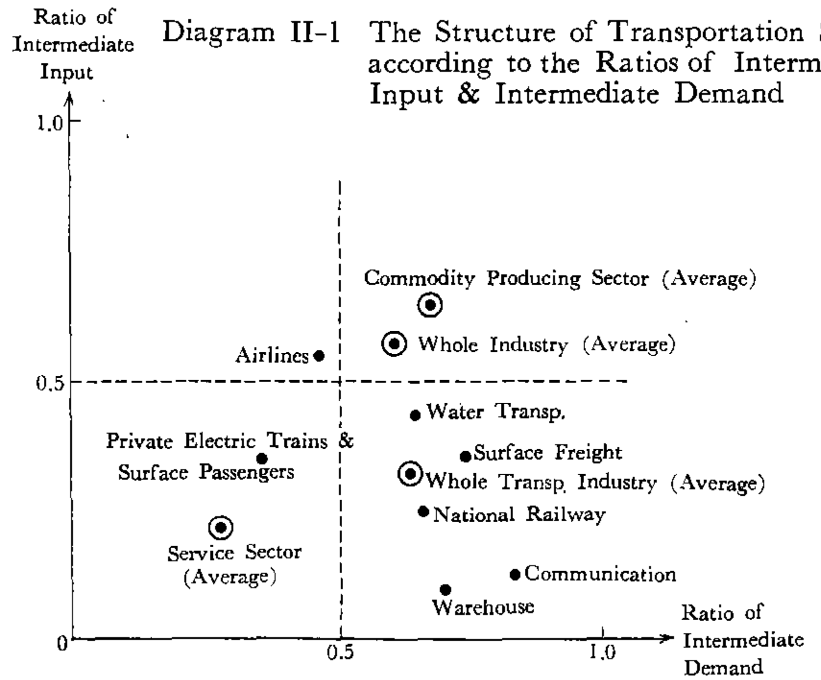
(%)

Item / Sub-section & Sector	Ratio of intermediate input	Ratio of value added	Component Ratios of Value Added					
			Non-household consumption expenditures	Earned income	Operating surplus	Capital depreciation allowance	Indirect tax	(Deductable) Subsidy
National railway	25.8	74.2	6.9	49.4	14.1	26.8	2.8	–
Private electric trains & surface passengers	33.8	66.2	2.4	56.7	14.5	24.4	2.0	–
Surface freight	36.9	63.1	4.0	53.7	18.0	22.6	1.6	–
Water transportation	44.3	55.7	3.7	44.1	24.4	25.3	2.6	−0.0
Airlines	53.5	46.5	5.9	40.1	22.7	28.3	3.0	–
Warehouse	12.7	87.4	2.0	59.4	29.3	6.3	3.0	–
Communication	18.2	81.8	1.6	49.7	28.0	19.4	1.4	–
Transportation sector	32.2	67.9	3.7	51.2	19.8	23.1	2.1	−0.0
Service sector	23.3	76.7	6.9	42.9	35.8	10.2	4.2	–
Commodity producing sector	65.9	34.1	4.7	31.0	44.0	9.8	10.9	−0.4
Average of Whole industry	55.7	44.3	5.4	36.6	39.4	10.9	7.9	−0.2

for the transportation sector (¥1,223,800 million), the earned income occupies a little more than half of it (51.2 %), showing a fairly high ratio in comparison with the 36.6 % average for the whole industry. This gives a straightforward demonstration of the fact that the extent of dependency on human labour in the field of transportation is considerably greater than in other fields[7]. The particular items which show a relatively greater weight with respect to value added component ratios next in the order of importance to this earned income are the 23.1 % of the capital depreciation allowance and the 19.8 % of the operating surplus, leaving all the rest lower than 5 %. Among all of these, the 23.1 % of the capital depreciation allowance exceeds the 10.9 % average for the whole industry to a marked extent. Furthermore, the weight of the capital depreciation allowance is greater than that of the operating surplus in each sub-section of the transportation sector, except for warehouse and communication. This can well be taken as an indication suggesting that the field of the transportation industry requires enormous capital and facilities.

Structural Position of the Transportation Sector

Diagram II-1 The Structure of Transportation Sector according to the Ratios of Intermediate Input & Intermediate Demand



Now, let us proceed to examine the structural position occupied in the whole industry by each sub-section of the transportation sector by observing the relationships of specific inter-sectional dependency among the sub-divided sections. This is self-explanatory if one refers to Diagram II-1. Because the ratio for intermediate demand is expressed in a hori-

7) The total sum of value added for the commodity producing sector and the service sector is ¥9,511,900 million and ¥5,672,800 million respectively.

zontal line, it may be assumed that the more to the right the plotting is made to represent one section, the higher the rate of intermediate demand for that section is represented, and conversely the more to the left it is, the higher the rate of final demand will be. In addition, because the ratio for intermediate input is expressed in a vertical line, it may be assumed that the higher the plotting is made, the stronger the tendency of being a productive business is represented, and conversely the lower its vertical position is, the stronger the tendency of its being a basic industry.

If these two factors are taken into consideration at the same time, it becomes possible to draw the following conclusions. First of all, the service sector belongs to the so-called basic industry developed as required by the final demand, in which both ratios for the intermediate demand and for the intermediate input are rather low. Contrarily, the commodity producing sector, in which both ratios for the intermediate demand and the intermediate input are so high, belongs to the type of productive business depending on the intermediate demand. But, in contrast with these two sectors, it is more adequate to conclude that the transportation sector, being characterized in general by a smaller ratio for the intermediate input, and also with a dispersing tendency in the ratio for the intermediate demand, belongs not so much to a basic industry of final demand as to a basic industry of intermediate demand.

Besides, from the fact that the ratio of the intermediate input for the transportation sector is small, it becomes possible to make a classification according to the component parts of value added as well as the component parts of final demand.

Transportation Input Ratio

Here for the present we shall see about the classification of the intermediate input ratios for each sector more in detail. Table II-3 shows the computed ratios for the transportation input according to each subsection and also the computed component ratios in relation to the whole intermediate input for each sector.

According to this table, the transportation input ratio for the commodity producing sector is so extremely low that the average ratio for this sector in relation to the total input is no more than 2.6 %, and the transportation input ratio for the service sector shows 2.9 % of the total sum of its input. Making a contrast with these findings, the input ratio for the transportation sector stands at 4.2 % of its total sum of input, and it is noticeable that such a rate is comparatively high when compared with the transportation input ratio for other sectors. This can also be substantiated from the fact that as much as 13.2 % out of 32.2 % of the

Table II-3 Transportation Input Ratio according to its Sub-Sections

(%)

Item / Sub-section & Sector	Input Ratio				Component Ratio			
	Commodity producing sector	Service sector	Transportation sector	Whole industry	Commodity producing sector	Service sector	Transportation sector	Whole industry
National railway	0.6	0.5	0.4	0.5	21.9	17.0	9.2	19.7
Private electric trains & surface passengers	0.3	0.9	0.7	0.4	9.8	31.2	17.0	15.0
Surface freight	0.7	0.1	0.2	0.6	27.3	3.1	4.7	20.4
Water transportation	0.5	0.1	2.1	0.5	17.6	3.1	49.6	16.8
Airlines	0.0	0.1	0.1	0.0	0.4	2.0	1.4	1.1
Warehouse	0.1	0.0	0.0	0.1	5.1	0.3	0.1	3.7
Communication	0.5	1.3	0.8	0.6	18.0	43.4	18.0	23.4
Transportation sector	2.6	2.9	4.2	2.7	3.9	12.6	13.2	4.9
Service sector	4.8	7.8	3.4	5.3	7.2	33.4	10.5	9.5
Commodity producing sector	58.5	12.6	24.6	47.4	88.9	54.0	76.4	85.6
Whole industry	65.9	23.3	32.2	55.7	100.0	100.0	100.0	100.0

intermediate input ratio for the transportation sector is occupied by its own input ratio, if the high ratio for the value added is taken into due consideration. As to the input ratio according to each of the sub-sections of the transportation sector, reference is suggested to be taken to the upper column of Table II-3[8].

III Analysis by Using Inverse Matrix Coefficients

All analyses previously given are primarily concerned with the reading of interindustrial input-output tables or input coefficients tables. They are only mere considerations of the more or less direct relationships of interdependency of the various sections with each other. Now, through the patterns of such direct structural relationships, we must further see how each section interacts with each other in its respective production activity——in other words to see the relationships of interdependency of the various sections with each other which involve indirect structural relationships lying beyond the field of the apparent direct interdependency.

Sensitivity and Power of Dispersion

For this purpose we have obtained the table of inverse matrix coefficients of a 35-section interindustrial consolidated table, i. e. $(I\text{-}A)^{-1}$. By taking this table as a clue it is possible to have a clear idea of the structural position of the transportation sector under particular circumstances for which any indirect effect of repercussion is taken into consideration. It is true that each individual element of these inverse matrix coefficients respectively represents the structural characteristics of its corresponding section, but because it would only lead to complications to take up all of them, for the present we shall adopt Rasmussen's sensitivity of dispersion coefficients and the power of dispersion coefficients as a convenient measure to reflect such structural characteristics[9].

8) These conclusions are limited to a great extent by the accuracy of the data provided by the interindustrial analyses on which they are based. But if it is taken into consideration that comparatively stable parameters are used in making estimates on the side of input at the stage of coordinated preparatory work, although it must be admitted that the estimates of indirect expenses (as in the case of the service sector, etc.) are lacking in exactness as compared with the estimates of the principal raw materials group (as in the case of the agriculture sector or electric power and gas, etc.), it can be regarded that they are adequate enough to be tolerably relied on. See Statistics Standard Bureau of Administrative Management of Agency.

9) If we take the element of the inverse matrix coefficients to be represented by b_{ij}, the coefficients of the sensitivity of dispersion and the power of dispersion are respectively expressed as

$$\left(\sum_j b_{ij} \Big/ \frac{\sum_i\sum_j b_{ij}}{n}\right)\times 100 \text{ and } \left(\sum_i b_{ij} \Big/ \frac{\sum_i\sum_j b_{ij}}{n}\right)\times 100$$

In short, the former is an index to represent the extent of the dispersion effect which one particular industry may receive from an other industry, and the latter is an index to represent the extent of the dispersion effect which one particular industry may have on an other industry. See Rasmussen, P. N., *Studies in Inter-sectoral Relations*, 1956, pp. 134–135.

Table III-1 Sensitivity of Dispersion Coefficient and Power of Dispersion Coefficient for the Transportation Sector

(%)

Item / Sub-section	Sensitivity of dispersion coefficient	Power of dispersion coefficient	Weighted sensitivity of dispersion coefficient	Weighted power of dispersion coefficient	Weight (final demand, total)
National railway	68.0	75.0	30.5	18.6	137,654 / 18,166,205
Private electric trains & surface passengers	63.0	85.4	38.9	45.0	292,211 / 18,166,205
Surface freight	66.8	89.1	26.5	13.5	83,814 / 18,166,205
Water transportation	70.3	95.3	26.0	21.3	123,633 / 18,166,205
Airlines	48.4	108.4	1.7	2.1	10,519 / 18,166,205
Warehouse	49.7	60.6	5.0	1.9	17,098 / 18,166,205
Communications	74.4	67.9	26.0	5.9	47,829 / 18,166,205

Table III-1 shows coefficients of both sensitivity of dispersion and power of dispersion for each sub-section of the transportation sector. According to this table it is seen that those coefficients for each sub-section of the transportation sector stands low, roughly speaking. However further examination in detail reveals that only in the case of communications does the sensitivity of dispersion coefficient exceed the power of dispersion coefficient, though to a very slight extent, and in all other six cases the former is observed to result in a smaller rate than the latter. This is evidently contradictory to the well-acquainted conclusion, " low coefficient for the power of dispersion, but high coefficient for the sensitivity of dispersion ", which used to hold good as an established common saying to point out one characteristic of the transportation sector[10). According to the result of our further search for the sensitivity of dispersion coefficient and the power of dispersion coefficient for the transportation sector based on the 1960 inverse matrix coefficient table, i. e. $(I-A+M)^{-1}$ (being composed of 56 sections and evaluated by the producers' price), these coefficients are found to be 184 and 94 respectively. This fact undoubtedly provides a theoretical proof to support the above stated conclusion that the transportation sector is a type of industry which is highly dependent on other industries.

10) For example, see Statistics Research Section of the Transportation Ministry Secretariat.

If so, it can be considered that the lowering phenomena of the sensitivity of dispersion coefficient in the case of ours must have been ascribable to the result of computation by using the inverse matrix coefficient table——$(I-A)^{-1}$——into which the import coefficient was not introduced in a definite manner. Be the matter as it may, when due consideration is given to the facts that in the current interindustrial input-output table the accuracy of data relating to the transportation as well as service sector is relatively lower than that of the commodity producing sector, and that in the case of the Japanese open economy special attention must be paid to handle the import coefficient, it is true that a hasty conclusion must not be made now. But at least it is our confirmed opinion that the results of our computation do take on no small meaning if the coefficients of both the sensitivity of dispersion and the power of dispersion are to be grasped not as an index of the influence of internal repercussion but as an index of the technical characteristics with respect to each industry.

It is noted that the aforementioned coefficients of sensitivity of dispersion and power of dispersion presuppose that each different sector in a whole system in which all industries are included has an equal right[11]. Consequently no consideration of the pattern of demand structure is given there. If it could be assumed that a certain sector would be affected to a greater extent by some influence arising from the final demand than it would by some influence through the input coefficient, then it could be inferred that by using a certain appropriate weight we could set that particular sector off from other sector. Therefore, in order to examine the correlation with the pattern of final demand we are led to compute the two coefficients of the sensitivity of dispersion and the power of dispersion, both of which are weighted by the component ratio of the final demand of each sector. The results are shown in the right half of Table III-1.

According to these computations the coefficients of each section of the transportation sector are all found to be lowered down. The reasons for this, we think, are firstly because the component ratio of the final demand occupied by the commodity producing sector is considerably greater than that of the transportation sector, secondly because both original coefficients of the sensitivity of dispersion and the power of dispersion which were not weighted before happen to be amplified owing to its relative greatness in magnitude in the commodity producing sector, and thirdly because the weighted coefficient in the transportation sector is conversely forced to make a marked decrease as the result of such after-effects. Furthermore, if our consideration is duly given to the fact that the distribution to the

11) Rasmussen, *op. cit.*, p. 135.

Table III-2 Amount of Induced Output according to Final Demand

(Unit: ¥ 1 million, %)

Item \ Final Demand	Non-household consumption expenditures	Private consumption expenditures	Government consumption expenditures	Total domestic fixed capital formation	Stock net increase	Export	Final demand Total
Sum of induced output for whole industry	1,790,773	17,084,176	2,530,398	13,282,734	1,733,422	4,529,543	40,951,024
Component ratio of induced output for whole industry	4.4	41.7	6.2	32.4	4.2	11.1	100.0
Coefficient of induced output for whole industry	202.3	202.0	153.5	277.9	255.8	263.6	225.4
Sum of induced output for transportation sector	52,804	887,746	124,150	424,150	50,860	275,916	1,809,105
Component ratio of induced output for transportation sector	2.9	49.1	6.9	23.4	2.8	15.3	100.0
Coefficient of induced output for transportation sector	3.0	5.2	4.9	3.2	2.9	6.1	4.4

endogenous sectors of the total output of the transportation sector is composed of revenue arising from passenger fares plus freight charges, while the distribution to the exogenous sectors of it (the accounts of final demand) is mainly composed of revenue arising from passenger fares only, it must be concluded that there is some doubt in taking the component ratio of the final demand as its weight[12].

Final Demand and Inducement to Output

Lastly we shall demonstrate an analysis of balancing on the basis of the relationships between the final demand and the inducement to the output. The result of our computation of the amount of total induced output according to each item of the final demand is shown in Table III-2.

This table shows that the total output induced by the private consumption expenditures (¥8,456,300 million) amounts to ¥17,084,176 million, ranking first on the list, followed in the order of importance by total domestic fixed capital formation, export, government consumption expenditures, non-household consumption expenditures and stock net increase. The total output induced by the sum of the final demand (¥18,166,205 million) amounts to ¥40,951,024 million. If we call the component ratio of the total induced output according to the items of the final demand the "component ratio of induced output for the whole industry", it is seen that only two items, the component ratios of induced output based on both the private consumption expenditures (41.7 %) and the total domestic fixed capital formation (32.4 %), come to constitute nearly 75 % of the total sum of the induced output for the whole industry. Again, if we call each sum of induced output divided by the respective item of the final demand the "coefficient of induced output for the whole industry", it becomes possible to make a clear finding about the effect of induced output caused by a unit-basis of each item of the final demand. It can be seen that by unit '1' of the final demand unit '2.25' of the output is induced as a whole and that the effects of induced output caused by such items as the total domestic fixed capital formation, export and stock net increase are outstanding above all others.

Now, we remind ourselves that what is meant by the sum of induced output for the whole industry given above is the total effect of the induced

12) Those sectors of industry which show a sudden rise by being weighted according to the total sum of the final demand are such industries as food, construction & civil engineering, electricity, textile, and service given to individuals. Moreover, we have tried a similar computation by further breaking down this weight according to each item of final demand. According to this result, it was observed that the weighted coefficient of the sensitivity of dispersion for private electric trains & other surface passengers which are weighted by private consumption expenditures rose to 69.01, and the weighted coefficient of the sensitivity of dispersion for water transportation which was weighted by export made rose to 98.33.

output on all industries induced by each item of the final demand. But, if only that particular effect of the output having an immediate bearing on seven sub-sections of the transportation sector is purposively taken up and is called the "sum of induced output for transportation sector", it is shown in the lower half of the Table III-2. Again, we shall call these component ratios the "component ratio of induced output for the transportation sector". If we compare it with the previous "component ratio of induced output for the whole industry", it can be clarified that the induced effects on the output for the transportation sector brought about by each item of the final demand are almost in parallel with those on the output for the whole industry. However, if we divide each sum of induced output for the transportation sector by the respective item of the final demand and call it the "coefficient of induced output for the transportation sector" and the needed computation is made, then among all the items of the final demand those items which have the highest inducing effect upon the transportation sector are the 6.1 % of export, then the 5.2 % of private consumption expenditures and the 4.9 % of government consumption expenditures, all of which are found to rank comparatively high. Nevertheless, particularly noticeable is that the total domestic fixed capital formation which shows the highest inducing effect for the whole industry, when analysed in detail, is found to have had its inducing effect inclusively to the commodity producing sector, and its effect of induced output for the transportation sector is no more than 3.2 %, which is less than 4.4 % of the coefficient of induced output for the transportation sector computed by the average for the final demand.

Now, we shall try to summarize the conclusions which we can draw from the analyses given above. After our examination of both ratios for the intermediate demand and for intermediate input, we first arrived at the conclusion that "the transportation sector as a whole belongs to the type of basic industry depending on the intermediate demand". In addition to this, when some indirect repercussions are taken into further consideration, we can state that "the effect of inducing output for the transportation sector per unit of the final demand can only be brought about to a very limited extent either by the capital formation or stock net increase, and this industry is rather characterized by the type of structure depending on consumption expenditures and export".

IV Analysis by Using 3-Industry-Group Model

Needless to say, an interindustrial input-output table is the table to show transactions of commodities carried on among various kinds of industries during a given period of time, but we can transform it from a mere descriptive device into an analytical tool by introducing some technical assumptions[13]. One of the most essential tools for that purpose is "the table of inverse matrix coefficients" which is obtainable from the table of input coefficients. By using this table, we can depict the interindustrial structure of a variety of industries to some extent.

It must, however, be kept in mind that although the coefficient of the inverse matrix can show the interacting effect of repercussions among different industries, it can not do anything beyond showing the "total effect of ultimate repercussion" under specific circumstances where all kinds of industries are taken into consideration collectively. Thus, when all industries involved in one interindustrial input-output table are divided into three sectors of a different nature, such as commodity producing sector, service sector and transportation sector, it is difficult to clarify the partial interactions between these sectors by using the ordinary method of analysis. In fact it is a matter of prime importance to make comparative studies of to what extent of percentage the total effect of ultimate repercussion for the commodity producing sector has been amplified through the activities of the service sector or transportation sector, and furthermore to take up the interindustrial relationships between any specific two sectors—say, the commodity producing sector and transportation sector in order to find the effect of repercussion of production activity of the former on the latter and that of the latter on the former. Yet, it can not be said that comparative studies of these problems have been sufficient.

Now, to give answers to these problems there is the necessity of further considerating them by dividing the ordinary coefficients of the inverse matrix into a certain number of phases. For the purpose of clarifying the partial interactions between the three specific industrial sectors, such as the commodity producing sector, service sector and transportation sector, we shall apply our "3-industry-group model" to the 1960 interindustrial input-output table[14].

13) Dorfman, Samuelson, Solow, [1], pp. 208–210. They pointed out the following three assumptions relating to technique: (i) constant returns to scale, (ii) convexity of the isoquant surface, and (iii) fixed coefficient of production.

14) In making an analysis of the interindustrial structure by dividing all industries into a certain number of industrial groups, the following two approaches are practicable:

(i) Analysis by the table of input coefficient matrix

(ii) Analysis by coefficient of inverse matrix table

As to (i) studies by Ghosh, [2] and Tsukui, [4] are worthy of notice. As to (ii) this study was initially started from the "2-group model" which was developed by Miyazawa, [3] and later Yamada & Ihara, [5] attempted to develop it into a "3-group model". It is attempted to present a set of theorems which hold in a "general group model" which can be composed of any given number of groups. A more rigorous and general model in "m" groups is given in Yamada & Ihara, [8], "Mathematical Formulation" in Appendix I.

A simplified table of 35 industries, which has already been prepared in chapter I, will be available. All industries to be contained in that table are grouped into the following three classifications:

Group I ⟶ Commodity Producing Sector (21 industries)
Forestry & fishery: coal, petroleum & natural gas: metal & other industry: food: textile: lumber, furniture, pulp & paper: printing & publication: leather & rubber: chemical industry: petroleum & coal product: cement, clay & stone: iron: metal product: electricity: precision & others: transportation machinery: construction & civil engineering: electric power: city-gas: water: unclassifiable:

Group II ⟶ Service Sector (7 industries)
Wholesale: retail: banking: insurance: real estate: service given to other works: service given to individual:

Group III ⟶ Transportation Sector (7 industries)
National railway: private electric trains & other surface passengers: surface freight: water transportation: airlines: warehouse: communications:

For convenience, we shall give the heading-number I to the commodity producing sector, heading-number II to the service sector and III to the transportation sector from now on.

When we set out to analyse the interactions between these three major industrial sectors "which one of them should be taken as the originating sector of interaction?" comes to rise up as an immediate question to be answered. In this connection it seems to be the governing opinion to consider that the activities of the commodity producing sector play a leading role when viewed from the aspect of all the economic activities, and that the activities of the service sector or the transportation sector are to be induced by the activities of the commodity producing sector. Consequently we shall take up the activities of the commodity producing sector for a start and then proceed to make a further analysis along that line.

Analysis of the Internal Propagation Ratio

The "own internal matrix multiplier" for the commodity producing sector B_{11} only represents the effects of internal propagation within the commodity producing sector without taking any account of the inducing effects on the other sectors. On the other hand, the "3-intersectoral internal matrix multiplier" for the commodity producing sector $B_{11}^{(3)}$ represents the total effect which is propagated on the commodity producing sector through a route which disperses through all three sectors in a manner such as: commodity producing sector⟶service sector⟶transportation sector. Therefore, if the internal matrix multiplier (B_{11}) of the former is computed and each of its elements is divided by the corresponding element which is in the same position of the internal matrix multiplier ($B_{11}^{(3)}$) of the latter, the coefficient which can be called the "internal propagation ratio" for the commodity producing sector is obtainable. The reason is because each of its elements indicates the ratio of the partial effect brought forth by the internal activity of the commodity producing sector itself on the total effect brought forth by the all interacting relationships among the three sectors of the same commodity producing sector. All of these internal propagation ratios are given in matrix form, and hereafter let us call its row mean and column mean the "affected internal propagation ratio" and the "affecting internal propagation ratio", respectively.

If based on the results of our computation, as far as the internal propagation ratio of the commodity producing sector is concerned, it has been found that the variance of the affected internal propagation ratio is greater than that of the affecting internal propagation ratio[15]. It may be understood as a reflection of the fact that the affected internal propagation ratio is fairly well governed by the nature of the industry. Therefore, those industries which belong to the commodity producing sector can be grouped together on the basis of the affected internal propagation ratio mentioned. This grouping is shown in Table IV-1[16].

Table IV-1 Industrial Grouping of the Commodity Producing Sector according to the Internal Propagation Ratio

		Names of Each Industry belonging to the Commodity Producing Sector
Group I	(1)	Metal & other industry: cement, clay & stone: chemical industry: electric power: metal products
	(2)	Agriculture, forestry & fishery: iron: food: precision & others: electricity
Group II	(1)	Coal, petroleum & natural gas: textile: lumber, furniture, pulp & paper
	(2)	Petroleum & coal products: water: city-gas
Group III	(1)	Construction & civil engineering: leather & rubber
	(2)	Printing & publication: transportation machinery

15) In making a contrast with the wide distribution of the affected internal propagation ratio for the commodity producing sector from 50 % to 90 % or over, its affecting internal propagation ratio is concentrated around 80's %. However, this is not applicable to the service sector or the transportation sector.

16) The classification of industry according to the internal propagation ratio and the way of its expression used here is taken from Miyazawa, [3], p. 111.

(Standard of Classification)

Group I...In this group are included those industries of which the affected internal propagation ratio exceeds 90 %. They are further divided on the basis of the distribution of the internal propagation ratio (distribution in a row of each element) into (1) which represents those industries in which the greater part of elements shows a higher ratio than 95 % and (2) which represents those industries in which the distribution is found around 95 %-80 %.

Group II...In this group are included those industries in which the affected internal propagation ratio shows 86 %-90 %. When viewed from the distribution of its internal propagation ratio, (1) represents those industries which include the ratio of 70 % up and (2) 60 % up.

Group III...In this group are included those industries in which the affected internal propagation ratio is lower than 85 %. Among them (1) represents those industries in which its internal propagation ratio is distributed extensively around 90 %-50 %, and (2) 70 %-30 %.

Remarks: The order of arrangement of names of industry within each group is governed by the grade of the affected internal propagation ratio. Unclassifiable industry has been omitted from the above table.

Table IV-1 is a brief list of industrial grouping prepared on the basis of the intensity of dependency of the commodity producing sector upon other sectors. Therefore, in this table a number of industries are so arranged that, as the grouping goes down from Group I to Group II and from Group II to Group III, the effect of the internal propagation within the commodity producing sector grows smaller and smaller, and conversely at the same time the intensity of dependency upon other sectors grows greater and greater. For example, over 90 % of all the activities of those industries which belong to Group I are dependent upon the internal propagation within the commodity producing sector itself: on the other hand as for those industries which belong to Group III, particularly two industries such as printing & publication, and transportation machinery, approximately 50 % of their entire activities are dependent upon the internal propagation within the commodity producing sector, and the remaining activities are dependent upon the propagation induced by other sectors.

Then, what is the reason that such different patterns, as shown in the above, came into existence? This question is the next one to be taken up.

Analysis of the External Matrix Multiplier

Here, we shall again reconsider the economic implication of the internal propagation ratios. As is clear from the definition, each of its elements can be interpreted to show "how much portion of the total effects of propagation was brought forth by the internal activities within the commodity producing sector itself?". In this case, by the total effects of propagation is meant such ultimate amplifying effects that are caused by the internal activities of the commodity producing sector which propagate starting from there to other two sectors (i. e. service sector and transportation sector) and again from there rebound back to the commodity producing sector. Consequently, if any difference in each element of the internal propagation ratios is observed, it may be assumed that such a difference is ascribable to the difference in the amplifying effect caused by other sectors.

Let us further examine this point in a more analytical form according to the following three phases:

(i) Partial effect of external matrix multiplier of the commodity producing sector arising from the channel of the transportation sector.

(ii) Partial effect of external matrix multiplier of the commodity producing sector arising from the channel of the service sector.

(iii) Secondary interacting effect owing to the mutual action of the above-mentioned two external matrix multipliers.

Now, the first phase means the amplifying effect caused by the internal activities of the commodity producing sector (B_{11}) through the channel of inducing relationships only with the transportation sector, having nothing to do with the propagation to the service sector. Therefore, its effects can be grasped as the "external matrix multiplier" of the commodity producing sector through the transportation sector (K_{11}^{3}).

The second phase is the amplifying effect upon the commodity producing sector brought forth in the inducing relationships only with the service sector, having nothing to do with the propagation to the transportation sector. Therefore, it can be grasped as the "external matrix multiplier" of the commodity producing sector through the service sector (K_{11}^{2}). But at this point it must be remembered that either one of the two concepts given in above only shows a partial effect of the external matrix multiplier between two sectors and that it does not show the whole effect of the external matrix multiplier among all three sectors. Consequently, in some cases, it is quite possible that the total effect of the external matrix multiplier shown by $K_{11}^{(3)}$ may turn out to be great, even if the partial effects of the external matrix multiplier shown by K_{11}^{2} or K_{11}^{3} is small. The foregoing description given in (iii) is intended to point out just what is discussed here and it enables us to grasp its effect by using $K_{11}^{(3)}$[17].

We must keep this point in mind when the results of actual computation of K_{11}^{2} or K_{11}^{3} are examined later. Firstly the partial effect of external matrix multiplier of the commodity producing sector through the transportation sector (K_{11}^{3}) is examined, and then all industries which belong

17) With respect to the total effect of the external matrix multiplier $K_{11}^{(3)}$ the following relations hold $K_{11}^{(3)}=K_{11}^{32}K_{11}^{2}=K_{11}^{23}K_{11}^{3}$.

to the commodity producing sector are further re-classified into three groups of Large, Medium and Small in conformity with the industrial division according to the previously given Table IV-1. What we obtained is Table IV-2.

Table IV-2 Partial Effects of the External Matrix Multiplier of the Commodity Producing Sector through the Channels of the Transportation Sector

		Names of Each Industry belonging to the Commodity Producing Sector
Group I	Large	Iron : electricity
	Medium	Agriculture, forestry & fishery: chemical industry: electric power: metal products
	Small	Precision & others: metal & other industry: cement, clay & stone: food
Group II	Large	Petroleum & coal products: coal, petroleum & natural gas
	Medium	Textile : lumber, furniture, pulp & paper
	Small	Water: city-gas
Group III	Large	Transportatin machinery
	Medium	Construction & civil engineering: printing & publication
	Small	Leather & rubber

(Standard of Classification)

Sub-group–Large ...In this group are represented those industries in which 0.001 or over is involved in an overwhelming tendency, when each element of K_{11}^3 is checked along the row. (If this is expressed by the row total, it means an industry in which the value stands at 1.02 or over.)

Sub-group–Medium...In this group are represented those industries in which each element of K_{11}^3 is distributed in the range of 0.001–0.0001. (Therefore, this group corresponds to those industries, of which the row totals range between 1.02–1.006.)

Sub-group–Small ...In this group are represented those industries, in which each element of K_{11}^3 is 0.0001 or less. (If seen from the row total, this group corresponds to those industries, of which its value is smaller than 1.006.)

Remark: The industrial division of Groups I, II and III is of the same nature as in the case of Table IV-1.

According to this table, the following points become clear. In those industries belonging to Group I the portion of internal propagation within the commodity producing sector is remarkably great, and accordingly they are of the type of industry which has the least dependency on the productive activities of other sectors. Among all these industries iron and electricity have comparatively rather strong inducing relationships with the transportation sector, and as a result the repercussion effects of their own productive activities are further amplified owing to this inducing relationships with the transportation sector[18]. In contrast with this case, all industries belonging to Group III are of the type of industry which has a considerable dependency upon the productive activities of other sectors. Among these industries as far as the partial effect of external matrix multiplier is concerned, the transportation machinery shows to be dependent on the transportation sector to such a great extent that its effect outdoes all the rest of the industries belonging to the commodity producing sector[19]. On the other hand, among all other industies belonging to the same Group III, industries like construction & civil engineering, printing & publication, and leather & rubber are also of the type of industry depending upon other sectors, but the partial effect of external matrix multiplier through the transportation sector is not so great.

If so, it leads us to assume that, as far as these industries are concerned, the amplifying effect arising from the service sector may be greater than the amplifying effect arising from the transportation sector. In support of this assumption we computed the external matrix multiplier of the commodity producing sector through the service sector (K_{11}^{2}). The result we obtained is Table IV-3.

Now, let us see what this table shows in comparison with the previous Table IV-2. Among all industries belonging to Group III, transportation machinery, for example, is effected to a considerable extent by the matrix multiplier through the transportation sector, showing the highest rate among the commodity producing sector, but it is not quite confirmed yet that the matrix multiplier through the service sector is just as great[20]. Conversely, printing & publication is much effected by the matrix multiplier not through the transportation sector but through the service sector, and the effect of the latter is the highest among the commodity producing sector[21]. Furthermore, when each element of the external matrix multipliers with respect to the two industries of construc-

18) For example, the row mean for iron seen from K_{11}^{3} is 1.0374 which is considerably greater than the 1.0177 of the average of the commodity producing sector. Such a result can be explained to the effect that the interindustrial propagation within the commodity producing sector resulted in having an amplifying effect of 3.74 % on the iron industry in the process of inducing relationships with the transportation sector.

19) The amplifying effect received by transportation machinery shows 5.42 %.

20) The amplifying effect of interindustrial propagation on the commodity producing sector rebounded back to its own sector in the process of inducing relationships with the service sector shows an increase of 1.69 % on an average, but the amplifying effect received by transportation machinery is 1.22 % which is below the average.

21) The amplifying effect received by printing & publication shows an increase of 0.59% when seen from its inducing relationships with the transportation sector, while it shows an increase of 6.47 % when seen from its inducing relationships with the service sector.

Table IV-3 Partial Effects of External Matrix Multipliers of the Commodity Producing Sector through the Channels of the Service Sector

		Names of Each Industry belonging to the Commodity Producing Sector
Group I	Large	Agriculture, forestry & fishery : iron : chemical industry
	Medium	Electricity : metal products : electric power
	Small	Precision & others : food : metal & other industry : cement, clay & stone
Group II	Large	Lumber, furniture, pulp & paper : textile
	Medium	Petroleum & coal products : coal, petroleum & natural gas
	Small	City-gas : water
Group III	Large	Printing & publication
	Medium	Construction & civil engineering : transportation machinery
	Small	Leather & rubber

(Standard of Classification)
The classification standard used for Table IV-2, was applied to K_{11}^{2} as it was.

tion & civil engineering, and leather & rubber is examined more in detail, it is found that the matrix multiplier through the service sector is greater, though slightly, than the matrix multiplier through the transportation sector in the former case, and an exactly opposite result is found in the latter case.

A similar elucidation of our computed results can be given with respect to those industries belonging to Groups I and II, but we shall omit a detailed discussion here.

But, there remains the following problem. In spite of the fact that those industries such as leather & rubber belonging to Group III or water and city-gas belonging to Group II were all prescribed, judging from the internal propagation ratios, as types of industry depending on other sectors, the amplifying effects of the external matrix multipliers for those industries (K_{11}^{2} or K_{11}^{3}) could not be observed to a noticeable extent. To this problem, we may suggest the following explanation. Judging from the fact that their internal propagation ratios for those above-mentioned industries are small, the total effect of external matrix multipliers for those industries ($K_{11}^{(3)}$) must be large. Hence, if it is true that the partial effects of the external matrix multipliers between the specific two sectors are observed to a slight extent, then, we may conclude that the secondary interacting effect owing to the mutual action of K_{11}^{2} and K_{11}^{3} (in other words, the mutual interacting relationships between the service sector and the transportation sector) must be large[22].

Analysis of the Coefficient Matrix of Inducement to Output & Input

So far we have pointed out the reasons why there arises an industrial difference in the internal propagation ratios of the commodity producing sector and developed some discussions about it. But it is also possible to continue our examination by dividing this inducing relationships with other sectors into somewhat different two phases. One of them is the examination of the effect of intersectoral inducement to output by the "coefficient matrix of inducement to output", and the other is that of the effect of intersectoral inducement to input by the "coefficient matrix of inducement to input".

With respect to the relationships between two such concepts and the external matrix multipliers we obtain the following equation as a theorem[23].

$$B_{11}^{3}=K_{11}^{3}B_{11}=B_{11}+\alpha_{13}B_{33}^{1}\beta_{31}$$

It shows that the total effects (B_{11}^{3}) within the commodity producing sector owing to the propagation between two specific sectors can be expressed either in the form of a product such as the "external matrix multiplier × internal matrix multiplier" (the 2nd formula) or in the form of a sum such as the "portion propagated within one sector + portion propagated from other sector" (the 3rd formula). Particularly according to the latter expression, among total effects of intersectoral propagation (B_{11}^{3}), the portion propagated from an other sector ($\alpha_{13}B_{33}^{1}\beta_{31}$) is given in a form separated from the portion propagated within its own sector (B_{11}). Consequently it comes to be ensured that the industrial difference in the internal propagation ratios, which we discussed by taking up the external matrix multiplier (K_{11}^{3} in the 2nd formula), can also be clarified by examining the coefficient matrix of the inducement to output (α_{13} in the 3rd formula) and the coefficient matrix of the inducement to input (β_{31} in the 3rd formula).

The second and third columns of Table IV-4 show the results of computation of α_{13} and β_{31} in brief. Now, firstly let us take up α_{13}. The reason why its column average is shown in the table is because it stands

22) The appropriateness of this interpretation can be substantiated by calculating the total external matrix multipliers (i. e. $K_{11}^{(3)}$) inclusive of propagation among all three industrial sectors.

23) It is based on 'Theorem 1-1' and 'Theorem 2-1'. See Yamada & Ihara, [8]. Incidentally B_{33}^{1} indicates the propagation of the transportation sector within its own sector in a case where the inducing relationships with the commodity producing sector is taken into consideration.

Table IV-4 Intersectoral Effects of Inducement to Output and Input between the Commodity Producing Sector and the Transportation Sector (Unit: %)

Each Name of Transportation Sector	Column Means of the Coefficient Matrix of Inducement to Output ($\alpha_{13}=B_{11}A_{13}$) : From the Transportation Sector to the Commodity Producing Sector	Row Means of the Coefficient Matrix of Inducement to Input ($\beta_{31}=A_{31}B_{11}$) : From the Commodity Producing Sector to the Transoprtation Sector	Row Means of the Coefficient Matrix of Inducement to Output ($\alpha_{31}=B_{33}A_{31}$) : From the Commodity Producing Sector to Transportation Sector
National railway	2.13	1.35	0.72
Private electric trains & other surface passengers	3.01	0.57	0.33
Surface freight	3.19	1.43	0.70
Water transportation	2.99	1.31	0.76
Airlines	4.73	0.03	0.02
Warehouse	0.92	0.19	0.09
Communications	1.43	1.21	0.66
(Average)	2.63	0.87	0.47

for "the affecting power of inducement to output given to the commodity producing sector by the commodity input of the transportation sector". According to our computed results, those values vary to a considerable extent. Among the transportation sector particularly those effects given by airlines are considerable, its power of inducement to output being 4.73 %, which is followed by surface freight (3.19 %), private electric trains & other surface passengers (3.01 %) and water transportation (2.99 %), each of which exceeds the average for the whole transportation sector. When each element of α_{13} is further examined to know which sub-sections of the commodity producing sector are highly affected by the effects of inducement to output, it is found that those industries which have the affecting power to a comparatively great extent are as follows: petroleum & coal products (17.0 %), transportation machinery (15.3 %) and iron (10.0 %) originated in airlines: transportation machinery (12.9 %) and petroleum & coal products (10.9 %) originated in surface freight : and transportation machinery (11.9 %) originated in private electric trains & other surface passengers.

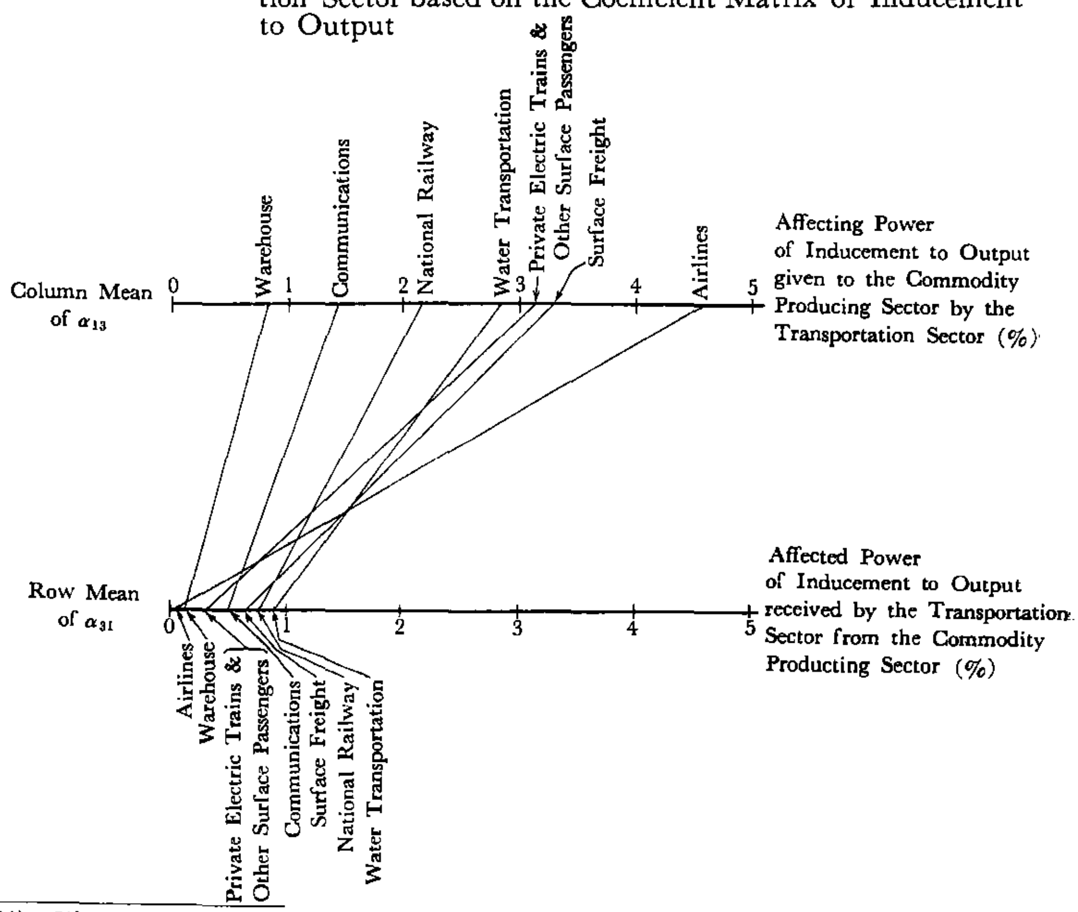
Next, as to β_{31}, its row means are calculated and shown in the third column of Tabe IV-4. The row means of β_{31} can be considered to represent "the affected power of inducement to input given to the transportation sector by the transportation input of the commodity producing sector".

Among all industries belonging to the transportation sector those which are affected to a comparatively great extent by the volume of orders necessitated by the productive activities of the commodity producing sector are surface freight (1.43 %), national railway (1.35 %), water transportation (1.31 %) and communications (1.21 %). However, it should be noted that the weight of β_{31} is remarkably smaller than that of α_{13} on the whole[24).

Naturally this leads to the conclusion that, as far as the mutually inducing relationships between two specific sectors, such as the commodity producing sector and the transportation sector are concerned, the affecting power of inducement to output given to the commodity producing sector by the commodity input of the transportation sector (α_{13}) are far greater than the affected power of inducement to input given to the transportation sector by the transportation input of the commodity producing sector (β_{31}).

Now, then, let us take one step further to examine this point. The

Diagram IV-1 Affecting Power and Affected Power for the Transportation Sector based on the Coefficient Matrix of Inducement to Output



24) When seen from the average, α_{13} is shown as 2.63 %, while β_{31} is shown as 0.87 %.

previously given α_{13} ($=B_{11}A_{13}$) was the coefficient matrix of inducement to output for the commodity producing sector brought forth by the commodity input of the transportation sector. But now the coefficient matrix of inducement to output for the transportation sector brought forth by the transportation input of the commodity producing sector ($\alpha_{31}=B_{33}A_{31}$) is computed to compare it with the former case, and its row means are shown in the fourth columns of Table IV-4. In this case, the row means of α_{31} can be considered to represent "the affected power of inducement to output given to the transportation sector by the transportation input of the commodity producing sector". Therefore, this affected power (row mean) of α_{31} is compared with the affecting power (column mean) of α_{13}, which is shown in Diagram IV-1.

From this diagram the following points are clarified: in the case of communications the effects of the inducement to output on the commodity producing sector are found to be relatively weak in comparison with other sub-sections but the effects of inducement to output received from the commodity producing sector are found to be relatively strong: conversely, in the case of airlines the effects of the inducement to output received from the commodity producing sector are found to be so slight that they can almost be disregarded, but the effects of the inducement to output on the commodity producing sector are found to be overwhelming. Be that as it may, when the mutually inducing relationships between the commodity producing sector and the transportation sector are to be examined by comparing the coefficient matrices of inducement to output (α_{13} versus α_{31}), it can be seen that the weight of α_{13} overwhelms that of α_{31} to a great extent[25], and this fact provides good proof to substantiate the aforementioned conclusion that the effects of the inducement to output brought forth by the transportation sector have great bearing.

It is possible to make a similar analysis with respect to the mutual relationships between the service sector and the commodity producing sector. Table IV-5 shows the computed results in brief with respect to the coefficient matrix of the inducement to output given to the commodity producing sector by the commodity input of the service sector ($\alpha_{12}=B_{11}A_{12}$), the coefficient matrix of the inducement to input given to the service sector by the service input of the commodity producing sector ($\beta_{21}=A_{21}B_{11}$) and the coefficient matrix of the inducement to output given to the service sector by the service input of the commodity producing sector ($\alpha_{21}=B_{22}A_{21}$). The discussion of this table in detail will be left to anyone perusing it, and the following one point which is especially noticeable

25) The weight of α_{31}, when seen from the average, is 0.47 %.

Table IV-5 Intersectoral Effects of the Inducement to Output and Input between the Commodity Producing Sector and the Service Sector (Unit: %)

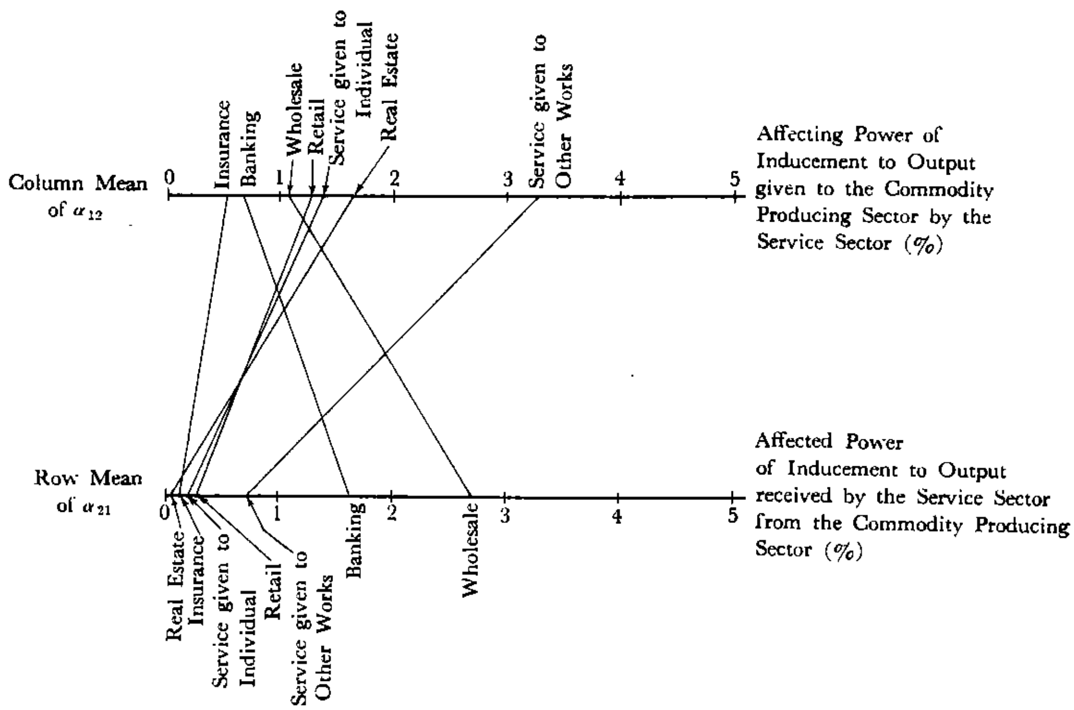
Each Name of Service Sector	Column Means of the Coefficient Matrix of Inducement to Output ($\alpha_{12}=B_{11}A_{12}$): From the Service Sector to the Commodity Producing Sector	Row Means of the Coefficient Matrix of Inducement to Input ($\beta_{21}=A_{21}B_{11}$): From the Commodity Producing Sector to the Service Sector	Row Means of the Coefficient Matrix of Inducement to Output ($\alpha_{21}=B_{22}A_{21}$): From the Commodity Producing Sector to the Service Sector
Wholesale	1.03	5.29	2.73
Retail	1.33	0.38	0.26
Banking	0.93	2.46	1.52
Insurance	0.84	0.22	0.11
Real estate	1.57	0.05	0.04
Service given to other works	3.28	1.57	0.87
Service given to individual	1.34	0.09	0.19
(Average)	1.47	1.44	0.82

will be taken up here. That is, when the extent of dependency of the commodity producing sector upon the productive activities of the service sector is analysed from the two phases such as the coefficient matrices of the inducement to output and input, it leads to the conclusion that the effects of the inducement to service input owing to the productive activities of the commodity producing sector (β_{21}) are almost comparable with the effects of the inducement to commodity output owing to the commodity input of the service sector (α_{12})[26]. This shows an outstanding contrast to the conclusion which was drawn from the mutually inducing relationships between the commodity producing sector and the transportation sector, asserting that the effects of the inducement to commodity output (α_{13}) are by far greater than the effects of inducement to transportation input (β_{31}).

Again, it can be interpreted that the column means of α_{12} represent "the affecting power of inducement to output given to the commodity producing sector by the commodity input of the service sector", and that the row means of α_{21} represent "the affected power of inducement to output

26) According to Table IV-5, α_{12} versus β_{21} are, when seen from the average, represented as 1.47 % versus 1.44 %. The reason why β_{21} comes to be greater than β_{31} is because among all the effects upon the service sector originated in the productive activities of the commodity producing sector, the effect received by the wholesale industry is particularly strong.

Diagram IV-2 Affecting Power and Affected Power for the Service Sector based on the Coefficient Matrix of Inducement to Output



given to the service sector by the service input of the commodity producing sector". These relationships pointed out here can be expressed as shown in the above Diagram IV-2. If the order of inducing powers with respet to each sub-section which belongs to the service sector based on this diagram are examined, it leads to the revelation of a number of interesting facts.

Analysis of the Augmented Input Coefficients

It must be noted that all explanations we have made so far are concerned with the so to speak partial repercussion effects between two specific sectors of industry, in particular between the commodity producing sector as the basis for making a comparison and another group of industry (transportation sector or service sector). Now, then, we shall proceed to see what change takes place when another industrial sector is allowed to intervene in the mutually inducing relationships between these two specific sectors of industry. In order to clarify this complicated matter we have proposed a concept which may be called the "augmented input coefficient". Our intention about it lies in assuming that (input coefficient by way of direct route) + (input coefficient by way of indirect route) form one consolidated input coefficient. With the aid of this newly defined concept, we can provide it possible to measure the very confused multiple interacting relationships characteristic of intersectoral dependency.

Tables IV-6 and IV-7 represent the computed results of the augmented input coefficients for three interacting relationships, such as transportation sector→service sector→commodity producing sector ($A_{13}^2=A_{13}+A_{12}B_{22}A_{23}$) and service sector→transportation sector→commodity producing sector ($A_{12}^3=A_{12}+A_{13}B_{33}A_{32}$)[27].

Table IV-6 Effects of the Commodity Input by the Transportation Sector through the Intervention of the Serveice Sector

Each Name of Transportation Sector	a Column Sum of the Input Coefficient (A_{13}): From the Transportation Sector to the Commodity Producing Sector	b Column Sum of the Augmented Input Coefficient (A_{13}^2): From the Transportation Sector to the Commodity Producing Sector via Service Sector	(b/a) ×100
National railway	0.2049	0.2104	102.7
Private electric trains & other surface passengers	0.2845	0.2900	101.9
Surface freight	0.2938	0.3113	102.6
Water transportation	0.2888	0.2966	102.7
Airlines	0.4478	0.4597	102.7
Warehouse	0.0931	0.0964	103.5
Communications	0.1352	0.1389	102.7
(Average)	0.2448	0.2509	102.5

Remark: The (averge) represents the weighted average of the respective column sum with the output of each sub-section belonging to the transportation sector as its weight.

Let us give a brief explanation to help easier understanding of what Table IV-6 means. The column 'a' represents each column sum of the ordinary input coefficients owing to the direct route, such as the commodity input of the transportation sector (A_{13}) and column 'b' represents each column sum of the augmented input coefficients (A_{13}^2). Therefore, a comparison of these two coefficients with each other enables us to measure the extent of the amplifying effects on the input relationships between the commodity producing sector and transportation sector through the intervention of the service sector. According to Table IV-6, its effects are reflected to be comparatively low, as they show an increase of 2.5% for the transportation sector as a whole, and the variance of these ratios

27) For the economic meaning of these concepts, see explanations in [5] or [8].

Table IV-7 Effects of the Commodity Input by the Service Sector through the Intervention of the Transportation Sector

Each Name of Service Sector	a Column Sum of the Input Coefficient (A_{12}) : From the Service Sector to the Commodity Producing Sector	b Column Sum of the Augmented Input Coefficient (A_{12}^{3}) : From the Service Sector to the Commodity Producing Sector via Transportation Sector	(b/a) ×100
Wholesale	0.0930	0.1047	112.6
Retail	0.1257	0.1316	104.7
Banking	0.0902	0.0964	106.9
Insurance	0.0841	0.0920	109.4
Real estate	0.1372	0.1373	100.1
Service given to other works	0.3314	0.3385	102.1
Service given to individual	0.1305	0.1353	103.7
(Average)	0.1260	0.1323	105.0

Remark: The (average) represents the weighted average of the respective column sum with the output of each sub-section belonging to the service sector as its weight.

according to each sub-section belonging to the transportation sector is also shown to be quite small. This can be made clearer if they are compared with the computed results shown in Table IV-7.

As to the amplifying effects on the input relationships between the commodity producing sector and service sector through the intervention of the transportation sector, they show an increase of 5.0 % on an average for the service sector as a whole, which is equivalent to twice the aforementioned amplifying effects brought forth by the intervention of the service sector. Again, if they are examined with respect to each sub-section belonging to the service sector, the indirect amplifying effects included in the commodity input of wholesales are greatest, the ratio running as high as an increase of 12.6 %. Other industries having high ratios are insurance (increase by 9.4 %) and banking (increase by 6.9 %) and all the rest are below the average.

So far we have tried to provide an explanation of the computed results with respect to the various coefficients which are obtained by dividing all industries into three big classifications, such as commodity producing sector, service sector and transportation sector. But, these results are only a part of what can be derived from our " 3-industry-group model". Needless to say, further analysis of various other kinds may be designed to serve other particular purposes, but we are, at least, confident that we could describe the specific characteristics of each industry to a considerable extent. It must be kept in mind, however, that the analysis given here amounts to no more than a comparative statics based on the inverse matrix coefficients. Consequently, our future problem is concerned with the know-how to link the pattern of final demands with the values of these coefficients and to make a more dynamic comparison.

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