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INTERINDUSTRY ANALYSIS AND UNIT STRUCTURE IN THE YUGOSLAV ECONOMY

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The idea of »Unit Structure« which has been proposed by Professor Ozaki is based upon the new interpretation of Leontief's inverse matrix. According to an accepted theory of the input-output analysis, the technology of an industry is expressed by the column vector of the input coefficients of each individual sector. As compared with this, Professor Ozaki puts out another interpretation; he defines the technology of »industry« as the transaction-relation of the intermediate goods which each individual sector induces in order to produce one unit of its final good.

Suppose an input-output table consisting of n industrial sectors. The following notations will be used throughout.

1) Column vector $X = [X_i]$, $i = 1, 2, \ldots, n$, to denote the output of the n industries.

2) Column vector $Y = [Y_i]$, $i = 1, 2, \ldots, n$, to denote the net (final) output of the economic system.

3) Matrix $Z = [X_{ij}]$ $i, j = 1, 2, \ldots, n$, to denote intersectoral transactions of the intermediate goods.

4) Column vector $S = [S_i]$, $i = 1, 2, \ldots, n$, to denote the capital goods (both fixed and circulating) necessary to obtain the output of i-th sector X_i.

5) Scalar L, to denote the amount of labour force required by the economic system, measured in man-year.

The technique of the whole economic system will be represented by

6) a matrix of input coefficients $A = [a_{ij}]$, $i, j = 1, 2, \ldots, n$, all $a_{ij} \geqq 0$, in which each column vector denotes the input of capital goods (here circulating materials) required for the production of one unit product of j-th industry.

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7) a row vector $a_{n+1} = [a_{n+1,j}]$, $j = 1, 2, \ldots, n$, all $a_{n+1,j} \geqq 0$, where each $a_{n+1,j}$ denotes the labour input required by one unit of product in j-th industry.

Lastly comes Leontief's inverse matrix.

8) Inverse matrix $(I - A)^{-1} = B = [b_{ij}]$, $i, j, = 1, 2, \ldots, n$.

In the usual interindustrial system, as is well-known, the technology of an industry is expressed by the input coefficient (column vector) of each column-located industry in the 1st quarter of the input-output table. Using input coefficient matrix A, we can write the balance equation between demand and supply for each industry as follows.

$$AX + Y = X$$

When final demand vector Y is given, we can obtain the corresponding output of each industry necessary to satisfy it. The solution is written like this.

$$X = (I - A)^{-1} Y$$

Now assuming that vector Y is equal to unit vector $[1, 1, \ldots, 1]^T$, we can get the special case of solution which shows the output of n kind of industries necessary to meet one unit of final demand for each industry.

Next let us suppose the final demand vector whose i-th element is equal to one unit and other elements are zero. In this case we can assume the each i-th column in Leontief's inverse matrix, $b_i^T = [b_{1i}, b_{2i}, \ldots, b_{ni}]^T$, shows the n kind of industries' products which are necessary to produce one unit of i-th sector's product. When we observe the normal relation $Y \Rightarrow B$ (that is, final demand determines direct and indirect output) from the reverse side, we can obtain the »Unit Structure«.

i column

$$\begin{bmatrix} b_{11} \ldots\ldots b_{1i} \ldots\ldots b_{1n} \\ b_{21} \ldots\ldots b_{2i} \ldots\ldots b_{2n} \\ \cdot \quad\quad \cdot \quad\quad \cdot \\ \cdot \quad\quad \cdot \quad\quad \cdot \\ \cdot \quad\quad \cdot \quad\quad \cdot \\ \cdot \quad\quad \cdot \quad\quad \cdot \\ \cdot \quad\quad \cdot \quad\quad \cdot \\ \cdot \quad\quad \cdot \quad\quad \cdot \\ \cdot \quad\quad \cdot \quad\quad \cdot \\ b_{n1} \ldots\ldots b_{ni} \ldots\ldots b_{nn} \end{bmatrix} \begin{pmatrix} 0 \\ \cdot \\ \cdot \\ \cdot \\ 0 \\ 1 \\ 0 \\ \cdot \\ \cdot \\ \cdot \\ 0 \end{pmatrix} \quad \text{i — row}$$

In the above figure, suppose the causal stream »from production to final demand« which starts from the i-th column vector $b_i^T =$

$= [b_{1i}, b_{2i}, \ldots, b_{ni}]^T$. In this case we can consider that as a result of n sectors having produced their products $b_{1i}, b_{2i}, \ldots, b_{ni}$ respectively, just one unit of i-th sector's final product has been produced.

Moreover if we take into the consideration the fact that definite parts of the sector's products $b_{1i}, b_{2i}, \ldots, b_{ni}$ are used as the intermediate materials, we can rewrite the above relation as the balance equation among intermediate goods, final demand and n kind of products.

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \begin{pmatrix} b_{1i} \\ \vdots \\ b_{ni} \end{pmatrix} + \begin{pmatrix} 0 \\ \vdots \\ 0 \\ 1 \\ 0 \\ \vdots \\ 0 \end{pmatrix} = \begin{pmatrix} b_{1i} \\ \vdots \\ b_{ni} \end{pmatrix}$$

The interdependence relation of transactions of intermediate goods in the above equation shows the »Unit Structure« itself.

In order to examine the transactions of intermediate goods more minutely, let us rewrite the first term of the left side of the above equation. Then we can get the form,

$$\begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \begin{bmatrix} b_{1i} & & & \\ & b_{2i} & & \\ & & \ddots & \\ & & & b_{ni} \end{bmatrix} \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{pmatrix}$$

The product of the left hand two items in this figure shows the pattern of inter-sectoral transactions of intermediate goods.

$$\begin{bmatrix} a_{11}\,b_{1i} & \cdots & a_{1n}\,b_{ni} \\ \vdots & & \vdots \\ a_{n1}\,b_{1i} & \cdots & a_{nn}\,b_{ni} \end{bmatrix} = \begin{bmatrix} U^i_{11} & \cdots & U^i_{1n} \\ \vdots & & \vdots \\ U^i_{n1} & \cdots & U^i_{nn} \end{bmatrix} \Rightarrow \begin{pmatrix} 0 \\ \vdots \\ 0 \\ 1 \\ 0 \\ \vdots \\ 0 \end{pmatrix} = Y_i$$

As a result of implementation of this pattern, one unit of final product of i-th sector has been produced. We call the matrix U^i as »Unit Structure« of i-th industry.

2. THE IMPLICATIONS OF »UNIT STRUCTURE«

The theoretical concept of the system of Unit Structure is understood as above mentioned. When this concept is combined with the quantitative data of the input output tables, this system has various implications for the economic analysis. We shall consider some main features of this concept including the suggestions by Professor Ozaki himself.

1) In the case of an accepted intersectoral analysis, the production technology has been grasped mainly as that of »industry«, namely, as the input coefficient column vector of each industry. That is to say, here, the technology is understood in isolation. As compared with this, the system of Unit Structure catches the technology of a industry as the intersectoral interdependence structure of the transactions of intermediate goods. It is the most remarkable feature of Unit Structure that it considers the technology as a system. As Professor Ozaki has pointed out, when we consider technology transfer abroad, or more generally when we treat the problem of the spreading of technology, such a systematic understanding of technology will prove to be effective.

2) As a natural consequence of the systematic understanding of technology, the method of measuring of the production efficiency will be different from the accepted ones. In the system of »Unit Structure«, the efficiency of production will be measured by the changes of the total inputs by the »set« of sectors which come into the interdependent relations. Namely, the production cost of i-th sector will be shown by the total sum of all U_{ij} in the corresponding

Unit Structure U^i. This sum total tells the socially necessary production cost of one unit of i-th product.

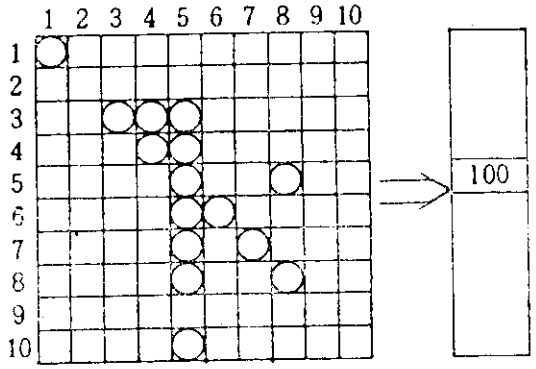
3) Relying on statistical analysis of the input-output tables of Japan, Professor Ozaki suggests that »Unit Structure« proves to be rather stable over the time horizon (he has compared two tables before and after big changes in the price system) and that this fact shows the existence of a stable pattern of technology structure in the basis of the given economic structure.

Moreover Professor Ozaki points out that each column-located coefficient of the given Unit Structure will change its amount in the industry's adjustment process to the changed relative prices (substitution process of factor-input) and that the distribution pattern of matrix U^i (U_{ij}) will change as the process of capital accumulation proceeds.

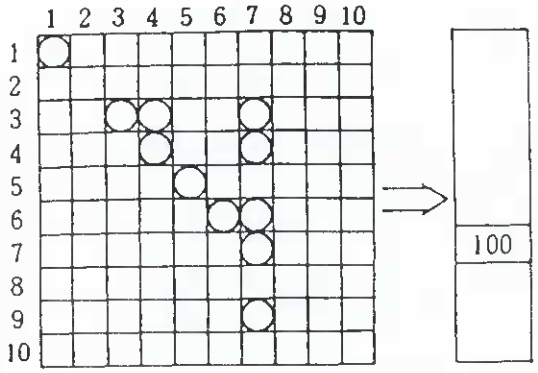
Judging from Ozaki's statements, we can see that here is proposed a new point of view which grasps the unit Structure as the »place of dialectic« which simultaneously reflects both the changes of relative prices and those of pure technology.

4) The next feature may be a rather secondary one, but it seems very interesting. The Unit Structure expresses the interdependence relations among industries as some kind of distribution chart of transactions U_{ij} on the chess-broad. We have made some samples.

The following two charts show the Unit Structure of two industries (metallurgy and manufacture of chemicals) in Czechoslovakia. These charts are made by calculating the data of Czechoslovakian Input-Output Tables (1973 and 1977). Each chart shows the intersectoral transaction pattern of intermediate goods (in the whole economic system) induced by the production of one unit (10 milliard Kcs) of the final product (metallurgy, chemicals, respectively). We have printed a »circle« in the box-point of intersection of rows and columns which has a transaction-value of more than one hundred million Kcs. In this sample we try to show the transaction relations among first ten sectors closely connected, while the original sector size is 28.



A. metallurgy (5 th sector)



B. chemicals (7 th sector)

5) As a natural corollary of the previous features, we can point out that »Unit Structure« grasps the change or progress of each sectors technology as a visual image. By using the time-series data of »Unit Structure« in one country, we could compare the technology system of the »past« with that of »today« in a visual form. Furthermore we could visualize the »perfect« pattern of the technological structure, the »moderate« one and the »primitive« one, using the different variant of each sector's »Unit Structure«. It also seems to be quite interesting to compare »Unit Structure« of the same industry among different countries or between the different social systems.

6) In the end, we can suggest the application of the concept of »Unit Structure« to the microeconomic area. The quantitative analyses made by Professor Ozaki are based upon the Input-Output Tables of Japan, which have the aggregation-size of 55 industries (the original table has the size of about 400 sectors). We see that his analyses are somewhat restricted by the big size of aggregation. If we can obtain more disaggregated tables (in some future time), we may draw up the chart of »Unit Structure« at enterprise level or individual workshop level. In these levels the analysis of »Unit Structure« will have more concrete forms and it will prove to be more effective, say, in the domain of the »decision-making« on the technology development.

3. »UNIT STRUCTURE« AND »VERTICALLY INTEGRATED SECTOR«

Next we would like to refer to the theoretical position of the concept of »Unit Structure« in the history of economics.

In 1973 (originally in earlier time), Professor Luigi L. Pasinetti presented a new idea, the »vertically integrated sector« as a fundamental category for the purpose of constructing the theory of »value and distribution« and that of »dynamic growth«. This »vertically integrated sector« can be expressed by the vector of a definite set of capital goods (»a unit of vertically integrated productive capacity«) and the vector of labour inputs (»vertically integrated labor coefficient«) for the production of one unit of final output of i-th industry.

This »vertically integrated sector« is, in fact, nothing else but the aggregated vector of each rows in the system of i-th sector's »Unit Structure«.

Let us look at the relation between »Unit Structure« and »Vertically Integrated Sector« of Pasinetti more minutely.

The system used here is that of the Input-Output Table defined in section 1 of this article. As for the coefficient matrix of capital stocks for the individual sectors, Pasinetti uses the concept of total capital which includes both the fixed and circulating capital goods. And he also uses the matrix of capital-output ratios (which we can get by dividing the capital goods required by the output of individual sectors X_i). But here for the purpose of simplification, we suppose the case where there is no fixed capital (in other words, we suppose the rate of depreciation equals to be 1). Therefore in our following explanation, the matrix of input coefficients is substituted for the matrix of capital coefficients.

Pasinetti has presented the balance system of »vertically integrated sector« in contrast to the balance system of »industry«. In the balance system of Pasinetti all the concrete transactions of intermediate goods are completely disregarded.

Now we introduce the vector of final demand Y_i in which only the final demand for the i-th product is positive and all the other elements are zero.

$$Y_i^T = (0, 0, \ldots, 0, Y_i, 0, \ldots, 0)^T$$

In this case the amount of the production of i-th sector which is induced directly and indirectly by the vector Y can be calculated as follows.

$$X^i = \begin{pmatrix} X_1^i \\ X_2^i \\ \vdots \\ X_n^i \end{pmatrix} = \begin{bmatrix} 1-a_{11} & -a_{12} & \cdots & -a_{1n} \\ -a_{21} & 1-a_{22} & \cdots & -a_{2n} \\ \vdots & \vdots & & \vdots \\ -a_{n1} & -a_{n2} & \cdots & 1-a_{nn} \end{bmatrix}^{-1} \begin{pmatrix} 0 \\ \vdots \\ 0 \\ Y_i \\ 0 \\ \vdots \\ 0 \end{pmatrix}$$

The amount of labour L_i which the whole system of the economy needs directly and indirectly for the production of the final demand vector Y_i is defined as follows.

$$L_i = (a_{n+1,1}, a_{n+1,2} \cdots a_{n+1,n}) \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \vdots & \vdots & & \vdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{bmatrix} \begin{pmatrix} 0 \\ \vdots \\ 0 \\ Y_i \\ 0 \\ \vdots \\ 0 \end{pmatrix}$$

Finally the stock of capital goods S^i (fixed capital and circulating ones) necessary for the production of final demand vector Y_i are calculated by multiplying the capital coefficient matrix A into the induced output (B * Y).

$$S^i = \begin{pmatrix} S_1^i \\ S_2^i \\ \vdots \\ S_n^i \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \begin{pmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \vdots & \vdots & & \vdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{pmatrix} \begin{pmatrix} 0 \\ \vdots \\ 0 \\ Y_i \\ 0 \\ \vdots \\ 0 \end{pmatrix}$$

In contrast to the balance system of industry, Pasinetti defines the following system

$$X^i = (I - A)^{-1} Y_i \tag{1}$$

$$L^i = a_{n+1} (I - A)^{-1} Y_i \tag{2}$$

$$S^i = A (I - A)^{-1} Y_i \tag{3}$$

as the balance system of the »vertically integrated sector«, $[S^i, L^i]^T$, which produces the net output Y_i.

Here he makes up the vector V from the first two terms of the right hand side of the expression (2).

$$a_{n+1}(I - A)^{-1} = (a_{n+1,1}\ a_{n+2,2} \cdots a_{n+1,n}) \begin{pmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \vdots & \vdots & & \vdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{pmatrix}$$

$$= (v_1, v_2, \cdots v_n) = V$$

In the same way he defines the new matrix H from the first two terms of the right hand side of the expression (3) as follows

$$A(I - A)^{-1} = H, \qquad \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \begin{pmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \vdots & \vdots & & \vdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{pmatrix} - \begin{pmatrix} h_{11} & h_{12} & \cdots & h_{1n} \\ h_{21} & h_{22} & \cdots & h_{2n} \\ \vdots & \vdots & & \vdots \\ h_{n1} & h_{n2} & \cdots & h_{nn} \end{pmatrix}$$

In this case the expression (2) is rewritten as L.

$$L^i = V * Y_i = V_i * Y_i$$

V of this expression means the amount of labour directly and indirectly necessary in the whole system to get the i-th product as a final demand. Pasinetti calls V_i »vertically integrated labour coefficient«.

The expression (3) is rewritten as follows:

$$S^i = HY_i,$$

$$\begin{pmatrix} S_1^i \\ S_2^i \\ \vdots \\ S_n^i \end{pmatrix} = \begin{bmatrix} h_{11} & h_{12} & \cdots & h_{1n} \\ h_{21} & h_{22} & \cdots & h_{2n} \\ \vdots & \vdots & & \vdots \\ h_{n1} & h_{n2} & \cdots & h_{nn} \end{bmatrix} \begin{pmatrix} 0 \\ \vdots \\ 0 \\ Y_i \\ 0 \\ \vdots \\ 0 \end{pmatrix} = \begin{pmatrix} h_{1i} \\ h_{2i} \\ \vdots \\ h_{2i} \end{pmatrix} Y_i$$

In this expression, Pasinetti has named the vector $h^i = (h_{1i}, h_{2i}, \ldots, h_{ni})^T$ as »a unit of vertically integrated productive capacity« for the i-th product.

By the way, Professor Ozaki's »Unit Structure« for the i-th final product Y_i can be shown as below by using the matrix of input coefficient and diagonal matrix of i-th column of Leontief's inverse matrix.

$$U^i = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \begin{bmatrix} b_{1i} & & & \\ & b_{2i} & & \\ & & \ddots & \\ & & & b_{ni} \end{bmatrix} = A\hat{b}_i$$

Now using the aggregation vector for the rows, the following expression can be obtained.

$$U^i e = A\hat{b}_i e = A \begin{pmatrix} b_{1i} \\ b_{2i} \\ \vdots \\ b_{ni} \end{pmatrix} \qquad e = (1, 1, \cdots 1)^T$$

The capital input structure of »vertically integrated sector« for the i-th final product $Y_i = 1$ is written as follows.

$$S^i = A\,(I-A)^{-1}\,Y_i$$

$$= A \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \vdots & \vdots & & \vdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{bmatrix} \begin{pmatrix} 0 \\ \vdots \\ 0 \\ Y_i \\ 0 \\ \vdots \\ 0 \end{pmatrix} = A \begin{pmatrix} b_{1i} \\ b_{2i} \\ \vdots \\ b_{ni} \end{pmatrix}$$

Therfore the vector S^i which is obtained by the aggregation of rows of Ozaki's »Unit Structure« U^i proves to be equal to the capital structure of »vertically integrated sector«.

4 THE SYSTEM OF UNIT STRUCTURE IN YUGOSLAVIA

In this section we shall give some experimental calculation of »Unit Structure« of industrial sectors of Yugoslavia using the numerical data of Input-Output Tables. Here we use the table of 1968 and that of 1974 each of which has 16 aggregated productive sectors.

As the size of aggregation is rather big, the results of our calculation may have only the meaning of a tentative experiment. But even if the technological relations lying within the basis of the economy proves to be rather strong, the basic tendency of the change of technology will reveal itself inevitably in the change of the shape of »Unit Structure«. Further analysis based upon more disaggregated tables is to be done later.

The items of calculation are as follows:

1) »Unit Structure« of two sectors

At first we calculate the Unit Structure of sectors based upon two different time points (1968 and 1974) and here we shall show the charts of the Unit Structure of two sectors< metallurgy> and <manufacture of chemicals>. Using the chart of the Unit Structure we can examine the stability of the technological structure and adjustment behaviour of each sector to the changes of relative prices.

2) the amount of the value added of individual sectors

As is known from the previous explanation, the amount of the value added of each sector will be calculated as follows.

The sum total of k-th column of the i-th sector's Unit Structure $\sum_{i=1}^{16} U_{ik}$ shows the material input cost of k-th sector. By substracting this amount from the k sector's output b_{ki}, we can get the amount of the value added of k-th sector as $VA_k = b_{ki} - \sum U_{ik}$.

This VA of each sector will be shown in the last row of the i-th sector's Unit Structure. Comparing this VA of each sector on two different time points each other, we can find the change of the efficiency of the given sector's production technique.

3) Capital inputs K of the »vertically integrated sector«

The sum total of each row of i-th sector's Unit Structure U^i shows the capital expenditure of i-th »vertically integrated sector« of the economy, the concept of which we have explained in section 3.

DATA AND RESULTS

a) Table 1 shows the Unit Structure of <metallurgy> (2 nd sector) in 1968.

Table 2 shows the Unit Structure of the same sector in 1974. Table 3 gives the Unit Structure of <manufacture of chemicals and paper> (5th sector) in 1968. Table 4 gives the unit structure of the same sector in 1974. In these Unit Structure we assumed that the size of the net output of i-th sector Y_i to be one hundred million dinars. And in each Unit Structure we have circled the cells of the matrix transaction which are more than two thousand dinars.

** Comparison of <metallurgy> between 1968 and 1974*

We can almost see the same shape of distributions of transactions U_{ij} (circles) between Table 1 and table 2. This fact shows that the technology structure of the production of <metallurgy> is rather stable over this time horizon. In these years relative prices have shown rather big changes. But despite of this fact, the existence of this stability shows that in the basis of the commodity production there lies an unchangeable »fundamental structure« of technology and suggests that no drastic technological changes have occurred for this time interval. In the Unit Structure any revolution of technology would be shown by the big change of distribution pattern U_{ij}.

At the same time we can find some changes of input structures for each column of the Unit Structure of <metallurgy>. See the 2nd column of the Unit Structure.

The input flow from the sector 2 shows heavy decrease (from 63.77 of 1968 to 33.88 of 1974 by almost 46%). On the other hand, input flow from 1st, 4th, 5th, 13th, 14th, 15th, 16th setor shows a slight increase. We can regard these changes as results of each sector's adjustment process to the changes of relative prices and also to the changes of allocation of resources.

** Comparison of <manufacture of chemicals and paper>*

The 5th column of the Unit Structure shows the input structure of this sector. We can read these results in almost the same way as that of <metallurgy>. It will be noticed that in this 5th column input flow from the 5th sector itself shows heavy increase (from 27.22 in 1968 to 40.66 in 1974) as compared with <metallurgy>.

* *The amount of value added of <metallurgy>*

In the last row of the Unit Structure the amount of the value added of each industry is shown. In the Unit Structure of <metallurgy>, the <metallurgy> sector itself appears to have produced the biggest amount of value added. Comparing the two tables, we can see that while the material inputs decrease from 88.21 in 1968 to 64.65 in 1974 (total sum of 2nd column), the amount of value added also decreases (from 76.16 to 70.17). This, although apparently impossible, may be explained by the difference of the amount of products between these two years.

* *The amount of value added of <manufacture of chemicals and paper>*

Comparing two Tables (Table 3 and Table 4), we can see that in four sectors (2nd, 5th, 6th, 10th) the amount of value added has been decreased and in other sectors the value added has been increased.

b) Capital input structure of »vertically integrated sector«

Table 5 and Table 6 show the capital (circulating) expenditure structure of sixteen »vertically integrated sector« for both years (1968 and 1974). As is known, each i-th column of both table shows the sum total of each row of the individual i-th sector's unit structure. For example, the first column of Table 5 is made up from the Unit Structure of 1st sector and shows the capital input structure of the 1st »vertically integrated sector« of the 1968 economy.

Table 6 will be read in the same way.

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(1) Iwao Ozaki »Keizia-hatten no Kouzou Bunseki« (1) — (3)«, [Mita Gakkai Zasshi] 1980.

(2) Statisticki Godisnjak Jugoslavije 1974, 1978 Beograd.

(3) L. L. Pasinetti: »The Notion of Vertical Integration in Economic Analysis«, [Metroeconomica] 1973.

Table 1. (ten thousand dinars)

Unit Structure of <metallurgy>

Yugoslavia 1968 Matrix U_{ij}

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ΣU_{ij}
1	1.81	8.21	0.18	0.04	0.07	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.29	0.23	0.01	0.11	10.78
2	0.05	63.77	0.04	0.38	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.04	0.03	64.37
3	0.04	2.07	0.20	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.01	0.01	0.04	2.49
4	0.20	2.04	0.05	0.48	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.24	0.01	0.10	0.24	3.83
5	0.11	1.02	0.07	0.06	0.38	0.02	0.03	0.00	0.02	0.00	0.00	0.00	0.01	0.02	0.01	0.01	1.78
6	0.03	0.33	0.02	0.03	0.01	0.10	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.04	0.00	0.61
7	0.02	0.27	0.01	0.03	0.01	0.02	0.21	0.00	0.00	0.00	0.00	0.00	0.06	0.01	0.06	0.00	0.71
8	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.04
9	0.01	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.14
10	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.01	0.00	0.04	0.01	0.00	0.00	0.01	0.00	0.00	0.15
11	0.06	0.12	0.01	0.00	0.05	0.11	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.36
12	0.11	0.23	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.05	0.02	0.00	0.03	0.56
13	0.26	3.63	0.08	0.05	0.04	0.02	0.01	0.00	0.00	0.00	0.01	0.02	0.25	0.04	0.02	0.03	4.47
14	0.22	2.37	0.08	0.10	0.24	0.02	0.02	0.00	0.00	0.00	0.00	0.03	0.27	0.05	0.16	0.05	3.42
15	0.09	0.92	0.03	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.09	0.02	0.01	0.01	1.24
16	0.03	2.54	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	2.66
VA	7.76	76.16	1.70	2.57	1.06	0.27	0.34	0.01	0.09	0.10	0.32	0.29	3.15	3.13	0.76	2.29	

Industries (rows and columns)

1. Energy
2. Metallurgy
3. Production and processing of non-metals
4. Processing of metals and electrical industry
5. Manufacture of chemicals and paper
6. Manufacture of wood
7. Manufacture of textiles, leather and rubber products
8. Food manufacturing industries and tabacco
9. Miscellaneous manufacturing industries
10. Agriculture
11. Forestry
12. Construction
13. Transport and communications
14. Trade and catering
15. Service rendering arts and crafts
16. Other

Table 2 (ten thousand dinars)
Unit Structure of <metallurgy>
Yugoslavia 1974

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ΣU_{ij} j
1	4.32	10.27	0.24	0.07	0.10	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.35	0.05	0.03	0.30	15.77
2	0.06	33.88	0.04	0.65	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.00	0.06	0.05	34.81
3	0.02	1.91	0.23	0.05	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.01	0.01	0.01	0.09	2.51
4	0.28	3.10	0.07	0.96	0.04	0.02	0.01	0.00	0.00	0.00	0.01	0.05	0.31	0.02	0.20	0.07	5.14
5	0.18	1.15	0.09	0.14	0.72	0.03	0.06	0.00	0.02	0.00	0.00	0.01	0.01	0.03	0.03	0.01	2.50
6	0.01	0.35	0.01	0.07	0.01	0.12	0.00	0.00	0.00	0.00	0.00	0.06	0.01	0.01	0.03	0.01	0.70
7	0.02	0.33	0.01	0.04	0.01	0.02	0.28	0.00	0.00	0.00	0.00	0.00	0.09	0.01	0.07	0.01	0.91
8	0.00	0.03	0.00	0.00	0.02	0.00	0.03	0.02	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.11
9	0.01	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.01	0.00	0.01	0.16
10	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.04	0.00	0.04	0.00	0.00	0.00	0.01	0.00	0.00	3.16
11	0.04	0.17	0.01	0.00	0.07	0.09	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.40
12	0.16	0.73	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.04	0.03	0.01	0.09	1.37
13	0.28	4.52	0.11	0.09	0.06	0.02	0.01	0.00	0.00	0.00	0.01	0.05	0.35	0.04	0.03	0.05	5.63
14	0.21	2.18	0.07	0.14	0.06	0.02	0.02	0.00	0.00	0.00	0.01	0.05	0.32	0.07	0.23	0.08	3.47
15	0.30	1.24	0.06	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.17	0.03	0.02	0.04	1.97
16	0.03	4.73	0.01	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.02	4.88
VA	9.83	70.17	1.53	2.81	1.29	0.34	0.42	0.03	0.10	0.09	0.34	0.71	3.92	3.13	1.24	4.05	

Table 3 (ten thousand dinars)

Unit Structure of <Manufacture of chemicals and paper>

Yugoslavia 1968 $U = [U_{ij}]$

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ΣU_{ij}
1	1.15	0.17	0.19	0.03	4.87	0.02	0.02	0.02	0.00	0.01	0.02	0.00	0.24	0.04	0.01	0.05	6.83
2	0.03	0.31	0.04	0.27	1.62	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.04	0.01	3.38
3	0.02	0.04	0.21	0.02	2.26	0.01	0.00	0.01	0.00	0.00	0.01	0.04	0.01	0.01	0.01	0.02	2.67
4	0.13	0.05	0.05	0.34	1.73	0.02	0.01	0.01	0.00	0.01	0.04	0.02	0.20	0.02	0.10	0.02	2.76
5	0.07	0.02	0.07	0.05	27.22	0.03	0.07	0.03	0.02	0.03	0.01	0.00	0.01	0.03	0.01	0.00	27.66
6	0.02	0.01	0.02	0.02	0.67	0.17	0.01	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.04	0.00	1.00
7	0.01	0.01	0.01	0.02	0.77	0.03	0.41	0.00	0.00	0.00	0.02	0.00	0.05	0.01	0.06	0.00	1.43
8	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.09	0.00	0.02	0.00	0.00	0.00	0.01	0.00	0.00	0.92
9	0.01	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.16
10	0.00	0.00	0.00	0.00	0.34	0.00	0.15	0.31	0.00	0.32	0.07	0.00	0.00	0.01	0.00	0.00	1.21
11	0.04	0.00	0.01	0.00	3.36	0.19	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	3.71
12	0.07	0.00	0.02	0.01	0.18	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.04	0.02	0.00	0.01	0.47
13	0.16	0.07	0.09	0.03	2.87	0.04	0.01	0.02	0.00	0.01	0.05	0.02	0.21	0.05	0.02	0.01	3.78
14	0.14	0.05	0.08	0.07	2.80	0.03	0.04	0.04	0.00	0.04	0.05	0.02	0.23	0.06	0.15	0.02	3.83
15	0.05	2.02	0.03	0.02	0.80	0.01	0.01	0.01	0.00	0.01	0.03	0.01	0.08	0.03	0.01	0.01	1.22
16	0.02	0.05	0.01	0.01	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00	1.14
VA	4.92	1.57	1.82	1.86	76.08	0.45	0.68	0.37	0.11	0.76	3.25	0.24	2.66	3.51	0,75	0.98	

Industries (rows and columns)

1. Energy
2. Metallurgy
3. Production and processing of non-metals
4. Processing of metals and electrical industry
5. Manufacture of chemicals and paper
6. Manufacture of wood
7. Manufacture of textiles, leather and rubber products
8. Food manufacturing industries and tabacco
9. Miscellaneous manufacturing industries
10. Agriculture
11. Forestry
12. Construction
13. Transport and communications
14. Trade and catering
15. Service rendering arts and crafts
16. Other

Table 4 (ten thousand dinars)

Unit Structure of Manufacture (chemicals and paper)
Yugoslavia 1974

Matrix U_{ij}

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ΣU_{ij}
1	2.49	0.19	0.39	0.05	5.41	0.01	0.02	0.02	0.00	0.01	0.03	0.01	0.28	0.06	0.03	0.06	9.07
2	0.04	0.63	0.06	0.48	1.20	0.01	0.00	0.00	0.01	0.00	0.00	0.02	0.01	0.00	0.06	0.01	2.53
3	0.01	0.04	0.37	0.04	3.48	0.00	0.00	0.01	0.00	0.00	0.01	0.06	0.01	0.01	0.01	0.02	4.08
4	0.16	0.06	0.11	0.71	2.09	0.03	0.02	0.02	0.00	0.01	0.10	0.03	0.24	0.02	0.19	0.02	3.80
5	0.10	0.02	0.15	0.11	40.66	0.04	0.11	0.05	0.04	0.03	0.01	0.01	0.01	0.04	0.02	0.00	41.41
6	0.01	0.01	0.02	0.05	0.52	0.15	0.00	0.00	0.00	0.00	0.01	0.03	0.01	0.02	0.03	0.00	0.86
7	0.01	0.01	0.02	0.03	0.83	0.02	0.50	0.00	0.00	0.00	0.03	0.00	0.07	0.02	0.06	0.00	1.61
8	0.00	0.00	0.00	0.00	1.20	0.00	0.05	0.32	0.00	0.07	0.00	0.00	0.00	0.01	0.00	0.00	1.64
9	0.01	0.00	0.01	0.01	0.20	0.00	0.00	0.00	0.04	0.00	0.01	0.00	0.01	0.02	0.00	0.00	0.31
10	0.00	0.00	0.00	0.00	0.20	0.00	0.10	0.61	0.00	0.35	0.02	0.00	0.00	0.01	0.00	0.00	1.29
11	0.02	0.00	0.01	0.00	3.77	0.11	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00	4.14
12	0.09	0.01	0.04	0.02	0.32	0.00	0.00	0.00	0.00	0.00	0.04	0.14	0.03	0.03	0.01	0.02	2.77
13	0.16	0.08	0.17	0.07	3.31	0.03	0.02	0.04	0.01	0.01	0.08	0.03	0.27	0.06	0.03	0.01	4.39
14	0.12	0.04	0.12	0.10	3.34	0.02	0.04	0.06	0.01	0.04	0.07	0.03	0.25	0.09	0.22	0.02	4.55
15	0.17	0.02	0.09	0.04	1.2	0.01	0.01	0.01	0.00	0.01	0.06	0.01	0.13	0.04	0.02	0.01	1.85
16	0.02	0.09	0.01	0.03	0.79	0.00	0.01	0.00	0.00	0.00	0.00	0.00	2.01	0.02	0.01	0.00	0.99
VA	5.66	1.31	2.50	2.07	72.88	0.42	0.74	0.49	0.18	0.75	3.45	0.40	3.05	4.11	1.17	0.82	

Table 5 (ten thousand dinars)

Capital input structure of < vertically integrated sector >,
Yugo 1968 *Matrix* K_{ij}

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	20.82	10.78	10.31	3.25	6.83	3.71	3.44	4.13	2.44	1.64	1.10	3.77	8.73	1.55	2.60	5.71
2	1.65	64.37	3.62	18.79	3.38	2.97	1.03	1.18	3.17	0.59	0.62	7.86	2.06	0.34	7.28	2.47
3	0.72	2.49	9.00	1.28	2.67	1.16	0.47	1.38	0.77	0.48	0.42	12.54	0.61	0.39	0.90	2.02
4	3.04	3.83	3.44	15.04	2.76	4.58	1.84	2.83	2.07	1.42	1.75	6.32	7.12	0.78	10.25	2.19
5	1.88	1.78	4.13	2.89	27.66	5.95	9.64	5.72	18.32	3.92	0.55	2.12	0.98	1.17	2.73	058
6	0.58	0.61	1.22	1.31	1.00	20.17	0.94	0.88	1.17	0.33	0.26	5.67	0.58	0.50	4.59	0.36
7	0.54	0.71	1.18	1.56	1.43	5.03	41.35	1.21	2.19	0.69	0.98	1.26	2.49	0.66	7.86	0.44
8	0.04	0.04	0.05	0.04	0.92	0.10	0.59	12.40	0.21	3.02	0.07	0.04	0.04	0.25	0.08	0.01
9	0.15	0.14	0.20	0.21	0.16	0.24	0.23	0.23	10.11	0.10	0.16	0.25	0.36	0.34	0.21	0.14
10	0.14	0.15	0.26	0.29	1.21	1.85	20.57	51.59	1.73	36.80	2.98	0.32	0.44	0.70	1.28	0.09
11	0.83	0.36	0.90	0.41	3.71	23.44	0.52	0.51	0.84	0.33	2.92	2.08	0.27	0.22	1.05	0.14
12	0.57	0.56	1.40	0.54	0.47	0.83	0.43	0.50	0.42	0.35	0.93	19.05	1.56	0.61	0.51	1.30
13	3.41	4.47	4.49	2.31	3.78	6.16	2.21	3.03	3.67	1.58	1.79	6.23	6.68	1.61	2.41	1.54
14	3.19	3.42	4.49	3.91	3.83	5.13	5.24	7.42	3.84	5.03	1.95	7.92	7.51	1.94	14.10	2.53
15	1.16	1.24	1.64	1.12	1.22	1.24	1.16	1.56	1.22	1.51	1.01	2.03	2.42	0.83	1.59	0.67
16	0.40	2.66	0.69	0.95	1.14	0.50	0.63	0.50	0.65	0.16	0.15	0.63	0.50	0.47	0.81	0.36
ΣK_{ij}	40.12	97.60	47.01	53.89	62.17	83.07	90.29	95.09	52.82	57.95	17.65	78.12	42.37	12.36	58.26	20.55

Industries (rows and columns)

1. Energy
2. Metallurgy
3. Production and processing of non metals
4. Processing of metals and electrical industry
5. Manufacture of chemicals and paper
6. Manufacture of wood
7. Manufacture of textiles, leather and rubber products
8. Food manufacturing industries and tabacco
9. Miscellaneous manufacturing industries
10. Agriculture
11. Forestry
12. Construction
13. Transport and communications
14. Trade and catering
15. Service rendering arts and crafts
16. Other

Table 6 (ten thousand dinars)

Capital input structure of <vertically integrated sector>, Yugo 1974

Matrix K_{ij}

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	38.69	15.77	16.30	5.88	9.07	4.77	4.53	4.57	3.79	2.72	1.83	5.23	10.20	2.32	4.01	9.37
2	1.63	34.81	3.58	21.28	2.53	2.46	1.11	1.22	3.56	0.62	0.91	5.97	1.96	0.38	6.56	1.36
3	0.57	2.51	0.59	1.98	4.08	1.34	0.75	1.37	1.05	0.63	0.61	11.32	0.60	0.45	0.97	2.39
4	3.85	5.14	5.18	24.70	3.80	6.15	3.15	3.17	3.07	2.03	3.70	6.76	8.27	1.08	13.67	2.66
5	2.69	2.50	6.63	5.87	41.41	9.64	14.65	8.33	23.85	5.06	1.01	3.18	1.51	1.74	3.59	0.99
6	0.40	0.70	1.11	2.17	0.86	20.66	0.67	0.55	1.07	0.41	0.54	6.75	0.50	0.60	2.52	0.53
7	0.62	0.91	1.45	1.98	1.61	5.65	45.16	1.02	2.32	0.71	1.25	1.32	2.94	0.70	5.55	0.42
8	0.07	0.11	0.16	0.17	1.64	0.40	6.41	28.66	0.50	9.10	0.11	0.12	0.21	0.32	0.32	0.04
9	0.20	0.16	0.30	0.34	0.31	0.30	0.47	0.29	16.52	0.15	0.22	0.29	0.44	0.46	0.40	0.23
10	0.11	0.16	0.24	0.29	1.29	0.90	15.61	65.83	1.45	42.45	0.77	0.22	0.39	0.56	0.70	0.16
11	0.47	0.40	0.69	0.54	4.14	16.67	0.58	0.44	1.07	0.33	5.36	1.69	0.18	0.23	0.53	0.20
12	1.88	1.37	1.77	1.13	0.77	1.08	0.66	0.72	0.60	0.45	1.43	23.09	1.16	1.03	0.78	2.53
13	3.07	5.63	6.03	3.77	4.39	5.38	2.68	4.65	4.23	2.18	2.57	6.12	7.40	1.64	2.77	1.69
14	2.76	3.47	4.80	4.75	4.55	4.82	5.13	7.55	5.02	5.47	2.50	6.65	7.21	2.39	13.37	2.37
15	2.94	1.97	3.23	1.89	1.85	2.06	1.36	2.09	1.78	1.85	1.84	2.19	3.72	1.02	1.68	1.18
16	0.41	4.88	0.55	1.68	0.99	0.41	0.67	0.44	0.60	0.18	0.17	0.62	0.53	0.43	0.71	0.51
$\Sigma_j K_{ij}$	60.35	80.48	62.60	78.42	83.29	82.68	103.58	130.89	70.49	74.32	24.83	81.51	47.23	15.36	58.12	27.20

MEĐUGRANSKA ANALIZA I JEDINIČNA STRUKTURA U JUGOSLOVENSKOJ PRIVREDI

Hiroyuki YOKOKURA

Rezime

U ovom članku prihvatio sam relativno nov koncept u teoriji input-output analize: jediničnu strukturu profesora Ozakija. Koncept jedinične strukture predstavlja jedan od najkrupnijih doprinosa poslednjih godina, ali — kako nam se čini — jedinična struktura još nije dobila zasluženu popularnost. Stoga u ovom članku težim da objasnim koncept jedinične strukture i da pokažem njegovu primenljivost u empirijskoj analizi makroekonomije. Članak je podeljen u četiri dela.

U prvom delu objašnjavam teorijski koncept jedinične strukture. Kao što je poznato, prva četvrtina input-output tabele izražava transakcione odnose polufabrikata da bi se proizveo dati skup finalnih proizvoda. Jedinična struktura je specifičan slučaj prve četvrtine input-output tabele. Ona pokazuje posebnu strukturu prelaznih transakcija da bi se proizvela jedna jedinica finalnog proizvoda samo u i-tom sektoru.

Za svaki pojedini sektor možemo stvoriti posebnu jediničnu strukturu. Jedinična struktura je zaokružena reprodukciona jedinica za samo jedan tip finalnog proizvoda. Ova jedinična struktura može se dobiti primenom Leontijevljeve invertirane matrice.

U drugom delu razmotrio sam neke karakteristike jedinične strukture. Prvo, jedinična struktura i-tog sektora ispoljava svoju proizvodnu tehnologiju kao specifični splet transakcija među sektorima.

Drugo, jedinačna struktura omogućava merenje proizvodne efikasnosti datog sektora na sistematičan način. Proizvodna efikasnost i-te grane meri se ukupnim inputima ili ukupnom novopridodatom vrednošću unutar jedinične strukture i-tog sektora.

Treće, jedinična struktura prikazuje tehnologiju date industrijske grane na vizuelan način, poput tabele na šahovskom polju. Korišćenjem jedinične strukture može se vizuelno prikazati »primitivna«, »umerena« i »usavršena« tehnologija. Korišćenjem ove tabele moguće je praviti poređenja tehnologije istog sektora u različitim zemljama. Na tim tabelama krugovima su označene krupne transakcije. Raspored krugova predstavlja vizuelni izraz jedinične strukture.

Četvrto i poslednje, sudeći po našim proračunima, može se reći da jedinična struktura deluje stabilno, postojano tokom relativno dugog vremenskog perioda.

U trećem delu članka komentarisana je teorijska pozicija jedinične strukture. Ovaj koncept je izneo profesor Ozaki 1975. godine. On je u tesnoj vezi sa Pasinetijevim konceptom »vertikalno integrisanog sektora«. Profesor Masajuki Ivata i ja otkrili smo ovu vezu i ovde dali objašnjenje.

Konačno, u četvrtom delu, izneti su neki rezultati empirijskih proračuna o jugoslovenskoj privredi.

Izračunavao sam jediničnu strukturu Jugoslavije koristeći njene tabele inputa/outputa za 1986. i 1974. i proučavao promene tehnologije i proizvodne efikasnosti.

Tabele 1 i 2 pokazuju jediničnu strukturu sektora metalurgije, a tabele 3 i 4 jediničnu strukturu hemijske i industrije papira.

Proračun pokazuje da je oblik svake jedinične strukture (distributivna šema transakcija U_{ij}) ostala slična u date dve godine. To znači da nije bilo bitnih promena u tehnologijama ovih sektora. Istovremeno, proračuni ukazuju da je došlo do izvesnih promena input-output strukture pojedinih sektora. Ove promene izražavaju proces prilagođavanja sektora promenama relativnih cena.

Tabele 5 i 6 pokazuju takozvani vertikalno integrisani sektor. Na dnu ovih tabela prikazan je ukupan input pojedinačnih sektora. Ovom prilikom ti zbirovi korišćeni su kao kriterijum efikasnosti privrede. Poređenjem ove dve tabele, vidimo da su samo dva sektora zabeležila povećanje efikasnosti od 1968. do 1974: metalurgija i uslužne delatnosti.