研 究

Input-Output Analysis of the Japanese Information-Service Economy[1)]

Naoko Igarashi

Abstract : The purpose of this paper is to analyze the industrial structure of the Japanese economy by making use of an input-output table. We develop a reconstituted I-O table taking into account the recent growth in the Information and Service sectors of the Japanese economy and show the following results : First, the shares of the primary information sectors and the secondary information sectors in both value added and total output have been increasing. Second, growth of the information sectors in Japan is induced by that in the information machinery sectors.

1. Introduction

In this paper, we investigate the industrial structure of the Japanese economy by making use of an input-output table. A variety of indicators highlights the contribution of information services to the Japanese economy. One of them is the increased shares of the service and information sectors to total GDP. Moreover, there are other factors which reflect the growth of service and information occupations (clerical, sales, professional jobs, and so on).

Machlup (1969) provides some of the pioneering work underscoring the importance of the information sector and calculates its size by using an econometric method. He defines the information sector as education, research and development, communication, information machinery and information services. Machlup (1969) accounts for the ratio of these sectors to GNP in U. S. and confirms that the U. S. is becoming an information oriented economy.

Porat and Rubin (1977) focus on information workers in the non-information sector. They calculate not only the ratio of information sectors to total GDP but also the informational activities in the non-information sectors. In particular, Porat and Rubin (1977) divide the economy into the information sector and the non-information sector and define that part of the non-information sector that produces information for this sector itself as the secondary information sector (**SIS**). In other words, the inputs and outputs among the information sectors is traded in established markets while those among the **SIS** have a non-marketed character.

The purpose of Porat and Rubin's study is to show how much value added, intermediate inputs and final demand the **SIS** generates. First, Porat and Rubin (1977) estimate value added in

SIS, consisting of employment income, capital depreciation, salaries of self-employed proprietors and unpaid family members. They derive employment income of **SIS** by multiplying the occupation by industry matrix with a vector of average wages and capital depreciation by using a table on fixed capital formation. Second, Porat and Rubin (1977) reveal the intermediate inputs of **SIS** by imputation. Third, Porat and Rubin (1977) define final demand of **SIS** as sales to the government (R&D) and royalty exports and imports. They show that the size of the information sector in U. S. is large in 1967. They explain this by the fact that the shares of value-added in both **PRIS** and **SIS** in total value-added are 25.1% and 21.1%, respectively.

Hiromatsu and Ohira (1990) and Engelbrecht (1986) apply Porat and Rubin's method to the Japanese economy. Karunaratne (1986) also applies Porat's method to the Australian information economy. These analyses contribute to the understanding of an information economy. Although Porat and Rubin's method to derive the **SIS** is elegant, it is further extended in this paper. First, we incorporate not only the **SIS** but also the secondary service sectors (**SSS**) in order to identify an increase in service workers in the non-information sectors (**NIS**). Most **PRIS** are contained in the service sectors in a broad sense. However, there are non-informational sectors in the service sectors, which are the personal service sectors including food business and so on. These sectors reveal the service sectors except for the **PRIS**. We call this the primary service sectors (**PRSS**). Therefore, we apply this idea to the secondary sectors and define the part of the non-information sector that provides service for this sector itself as the secondary service sectors (**SSS**) in the same manner as the **SIS** (see table 1-1).

Table 1-1 Classification of information occupations and service occupations

Information occupations	Science scholar, Technician, Judical-engagement, Certified public accountant. Licensed tax accountant, Teacher, Artist Journalist, editor, Designer, Musician, Administrative occupation, General-office clerk, Typist, Puncher, Communication engagement, Printing and bookbinding worker
Service occupations	Health and medical engagement, Religionist, Other special and tecnological occupation, Outside duty-office clerk, Transport office clerk, Sales engagement, Transport, Communication engagement, Warehouse-worker, Service occupation, Non-classification occupation

(Note) The classification of the information occupation follows Hiromatsu and Ohira (1990). See also the economic planning agency (1985). The classification of the information and the service occupations corresponds to the sector classification.

A second difference between Porat and Rubin (1977) and ours is the method used to estimate the value added of **SIS**. In particular, our method to derive the employment income of **SIS** is different from theirs. They assume that the wages by occupations are the same across sectors, and hence they calculate employment income of **SIS** by multiplying the occupation by industry matrix with a vector of average wages by occupation. We assume that wages by occupations differ across sectors and we compute the employment income of **SIS** and SSS by multiplying the ratio of the number of information workers and service workers in the **NIS** to the total number of workers by the employment income in the **NIS**. Although this method is simple, we can obtain the different wages by each occupations of industry.

Third, Porat and Rubin (1977) assume that the surplus of value-added of **SIS** is zero because they presuppose that the surplus in the U. S. is small. In the U. S., the ratio of surplus to GDP is 4.95% in 1975. On the other hand, although the ratio of surplus to GDP in Japan is smaller that in the U. S., the figures gradually increased from 0.22% in 1975 to 2.79% in 1989 (see table 1-2). An estimate of Japanese surplus is therefore be incorporated in the components of value added of **SIS**.[2)]

Table 1-2 The percentage of undistributied profits to GDP of manufacturing sectors in Japan (compared to U. S.)

	1975	1980	1985	1989
Undistributied profits (million yen)	98980	1631472	1945140	3190769
GDP (million yen)	44800900	70232300	94257300	114455200
Undistributied profits / GDP*100 (%)	0.22(4.95)	2.32(4.47)	2.06(0.92)	2.79(1.08)

Fourth, Porat and Rubin (1977) impute the value of intermediate inputs in the **SIS** and assume that inputs of the **NIS** from the **PRIS** are zero. However, the increase of non-goods inputs in the good sectors (Tachi (1985) defines this "softization") has caused the shares of **PRIS** and **PRSS** as intermediate inputs in the goods sectors to expand. Because of this, the performance of **NIS** as intermediate inputs to **SIS** should be shown. In addition, they assume that the inputs of **SIS** from the **NIS** is zero. However, the product of **NIS** is needed as intermediate inputs to **SIS**. If we take the **PRIS** as the printing sector, the **NIS** as the paper sector and the **SIS** as the printing section in the **NIS**. Then we can see that the **SIS** uses as much paper as the **PRIS**. Hence, it seems that the input structure of both the **PRIS** and **SIS** is similar, that is, the input structure of the printing section in the **NIS** is close to that of the **PRIS**. Thus, the performance of these transactions have gained importance with the rise of information and services in the economy.

This paper is organized as follows : In section 2, we present our assumptions and models taking account into the differences between our analysis and the earlier analyze. Section 3 contains the results for the performance of value added and total outputs of **PRIS**, **SIS** and other sectors and compare these to other results. Furthermore, we show the structure of intermediate inputs by using the reconstituted input-output table. Section 4 states concluding remarks.

2. The Reconstituted Input-Output Table

In this section, we discuss the method by which we reconstitute an input-output table incorporating the **SIS** and **SSS**. The main sources of data for this analysis come from the link input-output tables of 1975-80-85 and an employment matrix by occupation in 1975-80-85. We decompose the sectors into the **PRIS**, the **PRSS**, the information machinery sectors (**IMS**) and the non-information goods sectors (**NIGS**). This differs from Hiromatsu and Ohira (1990), who do not include the **IMS** in the **PRIS** and treat the **IMS** a support sectors of **PRIS**. Our classification of the **PRIS** is due to Machlup (1969), although he classifies the **IMS** as the

PRIS. We exclude them from the **PRIS**, because the input structures of the **IMS** and **PRIS** are extremely different.[3] We define the **PRSS** as the sector except the **PRIS** from the service sectors in a wide sense (see table 2-1). The sectors from which we extract the **SIS** are following : the **PRSS**, the **IMS** and the **NIGS**. We also extract the **SSS** from the **NIGS** and the **IMS**.

Table 2-1 Sector classifications

PRIS	Publishing and printing, Real estate agencies, Communication and Broadcasting, Education and Research, Advertising agencies, Research and information services, Electronic computing equipment renting, Judical, financial and accounting services, Civil engineering and construction services, Other business services, Motion picture production and supply, Movie theaters, Photo studios
NIGS	Agriculture and forestry and fishery(except Agricultural services), Mining, Food products, Textile products, Pulp and paper and wooden products, Chemical products, Petroleum refinery and coal products, Ceramic stone and clay products, Steel, Non-ferrous metal, Metal products, General machinery(except Printing and bookbinding and paper processing machinery, office machines), Household electric equipment, Heavy electrical equipment, Electric lighting fixtures and equipment, Other weak electrical equipment, Transportation equipment, Miscellaneous manufacturing products(except Writing instrument), Construction, Electric power, Gas and hot water supply, Water supply and sanitary services
IMS	Printing and bookbinding and paper processing machinery, Office machines, Electric audio equipment parts and accessories, Radio and television sets, Communication equipment, Electric measuring instruments, Precision instruments, Writing instrument and stationery, Office supplies
PRSS	Agricultural services, Trade, Financial and Insurance services, Real estate rent, House rent, Transport, Transport services, Public administration, Medical service and health and social security, Office machines renting and leasing(except electronic computing equipment), Car renting, Building maintenance services, Amusement and recreational services(except Motion picture production and supply, Movie theaters), Eating and drinking places, Hotel and other loding places, Other personal services

First, we classify sectors according to the method mentioned above. Second, we estimate the value added of the **SIS** and **SSS** by using the ratios of the number of information workers and service workers in the **PRSS**, the **NIGS** and the **IMS** to the total number of workers in these sectors respectively. Third, we show the amount of intermediate inputs of the **SIS** and the **SSS** by using the input coefficients of the **PRIS** and **PRSS**.

2-1 The calculation of the value added of the SIS and SSS

We assume that the employment income per capita by occupations differs across sectors and the method to derive the employment income of **SIS** and **SSS** is simply as follows. As we separate the **SIS** and **SSS** from the proper sectors by using occupations type, we assume that the employment incomes of **SIS** and **SSS** are determined by the number of workers. 'Proper' sectors means the sectors before decomposing into the **SIS** and **SSS**. We calculate the employment income of the **SIS** and **SSS** by multiplying the ratio of the number of information workers and service workers in each sectors to its total number of workers by employment income in the **IMS**, **NIGS** and **PRSS** (proper). Although this method is simple, it permits calculation

of different wages by occupation by industry. We derive other components of the value added of the **SIS** and **SSS** (capital depreciation, operating surplus and so on) by using the same method. V_N denotes the sum of value added of the **NIS** which consist of the **NIGS** and **IMS** (see figure 2-1). We get V_2 and V_3 which are the value addeds of the **SIS** and **SSS** by multiplying V_N by the ratio of the number of information workers and service workers. By V_1 we denote the value added excluding those of the **SIS** and the **SSS** from the value added of **NIS** (proper).

Figure 2-1

2-1-1 Original Input-Output table

	NIS	I	S	F	X
NIS	x_{11}	x_{12}	x_{13}	F_N	X_1
I	x_{21}	x_{22}	x_{23}	F_I	X_2
S	x_{31}	x_{32}	x_{33}	F_S	X_3
V	V_N	V_I	V_S		
X	X_1	X_2	X_3		

NIS : Non-information goods and Information machinery
S : Service sectors
I : Information sectors
F_N, F_I, F_S : Final demand of NIS, I and S
V_N, V_I, V_S : Added value of NIS, I and S
X : Total output

2-1-2 Reconstitued Input-Output Table

	Non-information sectors		Primary information sectors		Primary service sectors			
	NIS	SIS	SSS	PRIS	SIS	PRSS	F	X
NIS	y_{11}	y_{12}	y_{13}	y_{14}	y_{15}	y_{16}	F_N	Y_1
SIS	DIA	0	0	0	0	0	0	Y_2
SSS	DIA	0	0	0	0	0	0	Y_3
PRIS	y_{41}	y_{42}	y_{43}	y_{44}	y_{45}	y_{46}	F_I	Y_4
SIS	0	0	0	0	0	DIA	0	Y_5
PRSS	y_{61}	y_{62}	y_{63}	y_{64}	x_{65}	y_{66}	F_S	Y_6
V	V_1	V_2	V_3	V_4	V_5	V_6		
Y	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6		

(Note) By y_{ij} we denote the inputs in our reconstitued I-O table.

2-2 Intermediate inputs of the SIS and SSS

As indicated in the introduction, our method to calculate the intermediate inputs of the **SIS** and **SSS** differs from previous studies. Although it is simple, we assume that the input coefficients of the **SIS** and **SSS** are the same as those of the **PRIS** and **PRSS**. Our assumption is similar to the "commodity technology assumption" which means that each commodity uses the same technology for its production regardless of its sector or industry classification.[4)]

From the value added and total outputs of the **PRIS** V_4 and Y_4, we can calculate the value added coefficients of the **PRIS** as follows:

$$\frac{V_4}{Y_4} \tag{1}$$

In addition, we assume that the value added coefficients (the ratio of value added to total

outputs) of the **SIS** and **SSS** are the same as those of the **PRIS** and **PRSS**. Accordingly, we can express total **SIS** output by multiplying the reciprocal of the value added coefficients of the **PRIS** by the value added of the **SIS**. For example, we represent the total outputs of the **SIS**, Y_2 in the **NIS** as follows:

$$Y_2=\frac{Y_4}{V_4}\times V_2 \tag{2}$$

The input coefficients of the **PRIS** are as follows:

$$\frac{y_{i4}}{Y_4}\quad (i=1,\ 4,\ 6) \tag{3}$$

where y_{i4} $(i=1,\ 4,\ 6)$ stands for the inputs of the **PRIS** from the **NIS**, the **PRIS** and the **PRSS** respectively. We can show the intermediate inputs of the **SIS** in the **NIS** by multiplying the input coefficients (3) by the total outputs of the **SIS** in the **NIS** (2).

$$y_{i2}=\frac{y_{i4}}{Y_4}\times Y_2\quad (i=1,\ 4,\ 6) \tag{4}$$

where y_{i2} means the intermediate inputs of the **SIS** in the **NIS**. Next, we calculate the amount of **SIS** intermediate inputs in the **PRSS** by applying the above method. Value added of the **SIS** in the **PRSS**, V_5, (Figure 2-1-2) is derived by multiplying the value added of **PRSS** V_S by the ratio of the number of information workers in the **PRSS**. We can show the total outputs of the **SIS** in the **PRSS** Y_5 by multiplying V_5 by the reciprocal of the value added coefficients in the **PRIS** (1) as shown at (5).

$$Y_5=\frac{Y_4}{V_4}\times V_5 \tag{5}$$

By using this, we obtain the intermediate inputs of the **SIS** in the **PRSS** by using (3) and (5) as follows.

$$y_{i5}=\frac{y_{i4}}{Y_4}\times Y_5\quad (i=1,\ 4,\ 6) \tag{6}$$

Thus, we have calculated the intermediate inputs of the **SIS** in both the **NIS** and the **PRSS**.

Next, we derive the intermediate inputs of the **SSS** in the **NIS** by using the input coefficients of the **PRSS** in the same way as that of the **PRIS**. The input coefficients of the **PRSS** are as follows:

$$\frac{y_{i6}}{Y_6}\quad (i=1,\ 4,\ 6) \tag{7}$$

We compute **SSS** intermediate inputs in the **NIS** by the same method by which we get the intermediate inputs of the **SIS**. We obtain the value added of the **SSS** in the **NIS** V_3 (figure 2-1-2) by multiplying V_N by the ratio of the number of service workers in the **NIS** to the total number of workers in these sectors. We calculate total output of the **SSS** in the **NIS** Y_3 by multiplying V_3 by the reciprocal of the value added coefficients of the **PRSS** V_6/Y_6 as shown at (8).

$$Y_3=\frac{Y_6}{V_6}\times V_3 \tag{8}$$

We calculate the intermediate inputs of the **SSS** in the **NIS** by multiplying the input coef-

ficients of the **PRSS** (7) by the total outputs of the **SSS** in the **NIS** Y_3 as follows:

$$y_{i3}=\frac{y_{i6}}{Y_6}\times Y_3 \quad (i=1,\ 4,\ 6) \tag{9}$$

Thus, the method by which we calculate the intermediate inputs of the **SIS** and **SSS** is based on the assumption that the input structure of the **SIS** and **SSS** is the same as that of the **PRIS** and **PRSS**.

Next, we compute the residual after subtracting the intermediate inputs, the value added and the total outputs of the **SIS** and that of the **SSS** from **NIS** (proper non-information sector). In figure 2-1-2, the value added, the intermediate inputs and the total outputs of **NIS** are denoted by V_1, y_{i1} $(i=1,\ 4,\ 6)$ and Y_1 respectively.

We assume that the **SIS** and **SSS** in each sector sell their products only to the **NIS** and **PRSS** to which these sectors originally belonged. These appear as the diagonal elements in our reconstituted input-output matrix, because they are the intra-industry transactions which occur between two sides of the same sectors. (See figure 2-1-2) Consequently, sales to the proper sectors from **SIS** and **SSS** are the same as the total outputs of the **SIS** and **SSS**. Furthermore, the sales from these sectors to the other sectors become zero. We assume that the final demand for the **SIS** and **SSS** is zero since the sales to the government (R&D) and royalty exports, imports are small in Japan. Final demands for the **NIS**, the **PRIS** and the **PRSS** are derived from the usual input-output table. By using these assumptions, we can make a reconstituted input-output table incorporating the **SIS** and the **SSS**.

The commodity technology assumption generates a possibility that the inputs of the **NIS** and **PRSS** become negative. That is, the proportion of the information workers in the **NIS** and **PRSS** may be overestimated. Although occupations in these sectors are for the most part classified in the **SIS**, some office clerks should be not in the **SIS** but in the **PRSS**. If negative inputs of the **PRSS** from the **PRSS** result, we use the following method to find the new proportion of the number of information workers. By multiplying the proportion of the number of workers in the **SIS** of the **PRSS** by a certain weight, we set the inputs which are negative to zero. This method is based on Almon (1972). He sets the input coefficients zero which can make minus inputs by repeated calculation.[5]

The method for finding the weight is as follows. Using figure 2-1, we will explain how to find a certain weight such that the inputs into the **PRSS** from the **PRIS** is zero. In a 2×2 submatrix which is surrounded by the thick frame in figure 2-1-2, y_{65} is the inputs from the **PRSS** into the **SIS** in the **PRSS**. We have already calculated this in (6). The **SIS** in the **PRSS** sells its products only to the **PRSS**, which is shown as the diagonal matrix (DIA) in figure 2-1-2. The trade within the **SIS** is zero by assumption. y_{66} shows the amount of intermediate inputs of the **SSS** from itself. We calculate y_{66} by subtracting y_{65} (inputs from the **PRSS** to its accompanying **SIS**) and Y_5 (the inputs of the **PRSS** from the **SIS** in the **PRIS**) from X_{33} (inputs from the **PRSS** to itself). The elements of the diagonal matrix are equal to Y_5 which is the total outputs of the **SIS** in the **PRSS**. V_5 is calculated by multiplying the value added of **PRSS** (proper) by the proportion of the number of information workers in **PRSS** (proper) α, which is equal to $V_S\alpha$. We calculate the inputs y_{66} from the **PRSS** into itself as follows:

Table 2-2 The reconstituted input-output table

2-2- a

Unit : (million yen)

1975Year	NIGS	IMS	PRIS	SIS1	SIS2	SIS3	PRSS	SSS1	SSS2	NC	Sum of inputs	Final demand	Total
NIGS	79733515	2291071	2113428	1145411	139587	427253	12564659	409518	19796	2596478	101440716	72012648	173453364
IMS	1172407	141588	75329	41379	5644	17089	405153	12004	890	89134	1960617	5107714	7068331
PRIS	2992152	181105	2362759	809416	93398	398918	4147939	121788	7785	262731	11377991	9091945	20469936
SIS1	12192448	0	0	0	0	0	0	0	0	0	12192448	0	12192448
SIS2	0	994480	0	0	0	0	0	0	0	0	994480	0	994480
SIS3	0	0	0	0	0	0	2329212	0	0	0	2329212	0	2329212
PRSS	16143549	709286	1350182	806277	101237	313677	11364481	406059	25071	1745309	32965128	68377849	101342977
SSS1	3515114	0	0	0	0	0	0	0	0	0	3515114	0	3515114
SSS2	0	133880	0	0	0	0	0	0	0	0	133880	0	133880
NC	2672487	42834	414622	250140	31089	96328	1280592	45923	2825	0	4836840	1133397	5970237
Sum of inputs	118421672	4494244	6316320	3052623	370955	1253265	32092036	995292	56367	4693652	171746426	155723553	327469979
Sum of value-added	54918739	2557301	13893160	8381985	520888	1075947	70253224	2519822	77513	1180227	155378806		
Total output	173340411	7051545	20209480	12192448	994480	2329212	102345260	3515114	133880	5873879	327985709		

2-2-b

Unit : (million yen)

1980Year	NIGS	IMS	PRIS	SIS1	SIS2	SIS3	PRSS	SSS1	SSS2	NC	Sum of inputs	Final demand	Total
NIGS	133043746	4823982	4276372	2096422	360066	797678	23675038	702715	62319	4276986	174115324	106676323	280791647
IMS	2118669	302837	169987	83940	15498	34706	758954	19071	2623	286244	3792529	10832264	14624793
PRIS	5822912	424717	4501382	1426339	239359	741617	8907008	238829	25921	577418	22905502	15384581	38290083
SIS1	20751086	0	0	0	0	0	0	0	0	0	20751086	0	20751086
SIS2	0	2295562	0	0	0	0	0	0	0	0	2295562	0	2295562
SIS3	0	0	0	0	0	0	4121408	0	0	0	4121408	0	4121408
PRSS	25871709	1341148	2807428	1523528	243843	595706	20203545	643613	64778	2839113	56134411	116537789	172672200
SSS1	5388171	0	0	0	0	0	0	0	0	0	5388171	0	5388171
SSS2	0	361553	0	0	0	0	0	0	0	0	361553	0	361553
NC	3252411	348475	760677	417285	69372	161409	2071540	67085	7174	0	7155428	2274906	9430334
Sum of inputs	196248704	9898274	12515846	5547514	928138	2331116	59737493	1671313	162815	7979761	297020974	251705863	548726837
Sum of value-added	84216408	4823470	25311156	13885357	1154169	1790292	114760169	3716858	198738	1289153	251145770		
Total output	280465112	14721744	37827002	20751086	2295562	4121408	174497662	5388171	361553	9268914	549698214		

2-2-c

Unit : (million yen)

1985Year	NIGS	IMS	PRIS	SIS1	SIS2	SIS3	PRSS	SSS1	SSS2	NC	Sum of inputs	Final demand	Total
NIGS	134236623	7458117	5514456	2287163	683069	863440	29366072	856041	96520	2222230	183583731	131363843	314947574
IMS	3039825	1024657	350952	147992	44346	58748	1337458	33255	6115	189902	6233250	20173269	26406519
PRIS	8064052	1034039	7095246	1780261	444090	1069716	13736180	359734	52726	683928	34319972	20239354	54559326
SIS1	25854791	0	0	0	0	0	0	0	0	0	25854791	0	25854791
SIS2	0	5556632	0	0	0	0	0	0	0	0	5556632	0	5556632
SIS3	0	0	0	0	0	0	4990526	0	0	0	4990526	0	4990526
PRSS	31262091	2438107	4057000	1928678	588210	727934	26382391	844482	128894	1173154	69530941	158612306	228143247
SSS1	7095551	0	0	0	0	0	0	0	0	0	7095551	0	7095551
SSS2	0	698139	0	0	0	0	0	0	0	0	698139	0	698139
N-C	3513788	392565	692194	333914	107882	124208	1203982	38923	6391	0	6413847	158774	6572621
Sum of inputs	213066721	18602256	17709848	6478008	1867597	2844046	77016609	2132435	290646	4269214	344277380	330547546	674824926
Sum of value-added	102284922	8743475	35885543	17311648	2796485	2146480	153487514	4963116	407493	2179176	330205852		
Total output	315351643	27345731	53595391	25854791	5556632	4990526	230504123	7095551	698139	6448390	677440917		

(Note) The sum of rows does not equal the sum of columns because of computation errors. **SIS1** indicates the secondary information sector in the non-information goods sectors. **SIS2** indicates the secondary information sector in the information machinery sectors. **SIS3** indicates the secondary information sector in the primary service sectors. **SSS1** indicates the secondary service sector in the non-information goods sectors. SSS2 indicates the secondary service sector in the information machinery sectors.

$$y_{66}=X_{33}-y_{65}-Y_5 \tag{10}$$

Y_5 equals $y_{15}+y_{45}+y_{65}+V_5$ which is the sum of the intermediate inputs and the value added of the **SIS** in the **PRSS**. Therefore, (10) becomes:

$$y_{66}=X_{33}-y_{65}-(y_{15}+y_{45}+y_{65}+V_5) \tag{11}$$

If y_{66} is negative, we calculate a certain weight to set y_{66} zero as follows: From (5), (6) and (11) we obtain

$$y_{66}=X_{33}-\frac{2y_{64}V_S\alpha}{V_4}-\frac{y_{14}V_S\alpha}{V_4}-\frac{y_{44}V_S\alpha}{V_4}-V_S\alpha \tag{12}$$

For simplicity, denoting y_{i4}/V_4 as $\lambda_i(i=1,\ 4,\ 6)$, then (12) can be rewritten as follows:

$$\begin{aligned} y_{66}&=X_{33}-(2\lambda_6V_S\alpha+\lambda_1V_S\alpha+\lambda_4V_S\alpha+V_S\alpha)\\ &=X_{33}-V_S\alpha(2\lambda_6+\lambda_1+\lambda_4+1)\end{aligned}$$

The weight ω^* which sets y_{66} zero is given by:

$$y_{66}=X_{33}-V_S\alpha\omega^*(2\lambda_6+\lambda_1+\lambda_4+1)=0$$

Now we get a new ratio of the number of information workers who are in the **SIS** in the **PRSS** by multiplying ω^* by α.

Furthermore, we can find the weight by this method when the inputs from the **NIS** into itself takes a negative value. Thus, we have all inputs of the industries in the reconstituted input-output table (see table 2-2-a, 2-2-b and 2-2-c).

3. The Results

3-1 The performance of the value added and total output of PRIS and SIS

First, we show the size of value added and total outputs of **PRIS** and **SIS** and compare the results to other studies. Table 3-1 indicates that the share of value added and total outputs of both **PRIS** and **SIS** increased during 1975-85. The share of value added of **PRIS** rose to 10.9% in 1985 from 8.9% in 1975. Also, the share of total outputs of **PRIS** expanded from 6.2% in 1975 to 7.9% in 1985. Furthermore, an increase in the share of value added of **SIS** from 6.4% in 1975 to 6.7% in 1985 is observed, with a similar trend observed for total outputs of **SIS** from 4.7% in 1975 to 5.4% in 1985. These figures differ from those of Hiromatsu and Ohira (1990) and Engelbrecht (1986) who investigated the Japanese economy as follows. First, Hiromatsu and Ohira (1990) express that the share of value added of **PRIS** and **SIS** are 3.95% and 26.7% and the share of total outputs of both sectors are 3.37% and 14.7% in 1985. The difference between the size of **PRIS** of our results and theirs is due to the classification of **PRIS**. Hiromatsu and Ohira (1990) defines the **PRIS** as the sectors which produce the informational goods and do not include education and printing sectors in the **PRIS**. They treat these sectors as support sectors for **PRIS** and separate these from the **PRIS**. Our classification of these sec-

Table 3-1 The size of **PRIS**, **SIS** and **NIS** in Japan, U. S. and Australia (%)

	Value-added			
	U. S. (1967)	Japan(1985)	Japan(1980)	Australia(1977)
	Porat & Rubin	Hiromatsu & Ohira	Engelbrecht	Karunaratne
PRIS	25.1	3.95	21.5	19.4
SIS	21.1	26.7	22.4	15.9
NIS	53.8	69.4	56.1	64.7
	Output			
PRIS	18.6	3.37	14.4	16.2
SIS	13.5	14.7	13.9	15.4
NIS	67.9	81.9	71.7	68.4
	Final demand			
PRIS	21.5	0.77	15.1	13.3
SIS	1.0	0	0.1	15.4
NIS	77.5	99.23	84.8	70.8

Our results

	Value-added		
	1975	1980	1985
PRIS	8.94	10.1	10.9
SIS	6.42	6.7	6.74
SSS	1.67	1.56	1.63
NIS	82.97	81.64	80.73
	Output		
	1975	1980	1985
PRIS	6.16	6.88	7.91
SIS	4.73	4.92	5.37
SSS	1.11	1.05	1.15
NIS	88	87.15	85.57

tors includes them in the **PRIS**. Thus, we define the **PRIS** in a broader sense than Hiromatsu and Ohira (1990).

Our classification of **PRIS** is based on Machlup (1980), however, the table in our model excludes information machinery from the **PRIS** because the input structures of the information machinery and **PRIS** exclusive information machinery are different. Therefore, the share of value added and total outputs of **PRIS** are larger than those Hiromatsu and Ohira (1990) derived.

The value added and total outputs in **PRIS** we derived indicate the Japanese economy in 1980 is smaller than Engelbrecht (1986) (The figures of value added is 21.5% and those of total outputs is 14.4%). The difference is also due to the classification of **PRIS** Engelbrecht (1986) used. He includes the finance, insurance and real estate sectors in the **PRIS**. Since the share of value added and total outputs of these sectors to the whole economy is large, the figures of the

PRIS are large relative to our results. Second, we explain the figures of **SIS** in our model in comparison with Hiromatsu and Ohira (1990) and Engelbrecht (1986). The difference between theirs and ours is attributable to the method to derive the value added of **SIS**. They employ the Porat and Rubin (1977) method. As we noted in the introduction, Porat and Rubin (1977) treat employment income, capital depreciation, salaries of self-employed proprietors and unpaid family members of the information workers in the **NIS** as the value added of **SIS**. They estimate employment income of **SIS** by multiplying the occupation by industry matrix with a vector of average wages of each occupation. Thus, they assume that the wages by occupations are the same irrespective of the sectors.

Our research assumes that wages by occupations differ between sectors. We calculate the employment income of the **SIS** and **SSS** by multiplying the ratio of the number of information workers and service workers in the sectors to its total number of workers by the employment income in the **NIGS**, **IMS** and **PRSS** (proper). Although this method is simple, we can derive the different wages by each occupation by industry. Table 3-2 indicates the wages per capita per month of each **SIS** and **SSS** in Japan during 1975-85. In this table, it is shown that there are some differences between wages in the **SIS** and **SSS**. The wages of **SIS** (**SIS1, SIS2 and SIS3**) are close to those of **PRIS**. In particular, the wages of **SIS2** are roughly equal to those of **PRIS**. Furthermore, we can see that the wages of **SSS2** are larger than those of **PRSS**. Thus, we can see wage differences across sectors despite the same type of occupations.[6)]

Table 3-2 Monthly wages per capita

Yen / per capita

	1975	1980	1985
PRIS	224125.89	305441.31	358312.48
SIS1	158844.78	248736.97	295884.12
SIS2	217083.38	342318.78	371114.02
SIS3	186191.80	273498.06	336981.23
PRSS	173184.86	244337.29	303594.77
SSS1	144983.81	231502.13	273954.08
SSS2	203868.81	336022.09	368067.03

Let us compare the performance of value added and total outputs of **PRIS** and **SIS** with those of other sectors. Figure 3-1-1 stands for the structure of value added by sectors. From figure 3-1-1, we can see that the ratio of value added in the **PRSS** to total value added of the whole economy has been rising as well as those of **PRIS**. Yet, the increase of the ratio in the **PRIS** is larger than the one in the **PRSS**, which demonstrates a general tendency toward an information-oriented economy. Moreover, it is shown that the value added of **IMS** has an upward trend. This is due to the diffusion of information machinery in recent years. On the other hand, the share of **NIGS** has been decreasing. This is explained by the change in industrial structure, overall production has been shifting from the primary industries to the tertiary industries.

Figure 3-1-2 summarizes the structure of total outputs by sectors. In this figure, we can definetly confirm the tendencies suggested in figure 3-1-1. Next, we show value added and total

Figure 3-1-1 Value-added structure

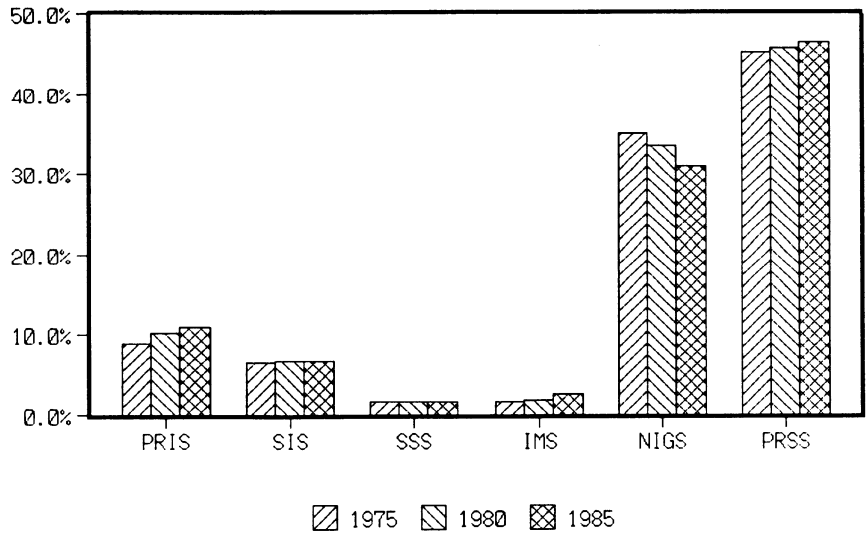
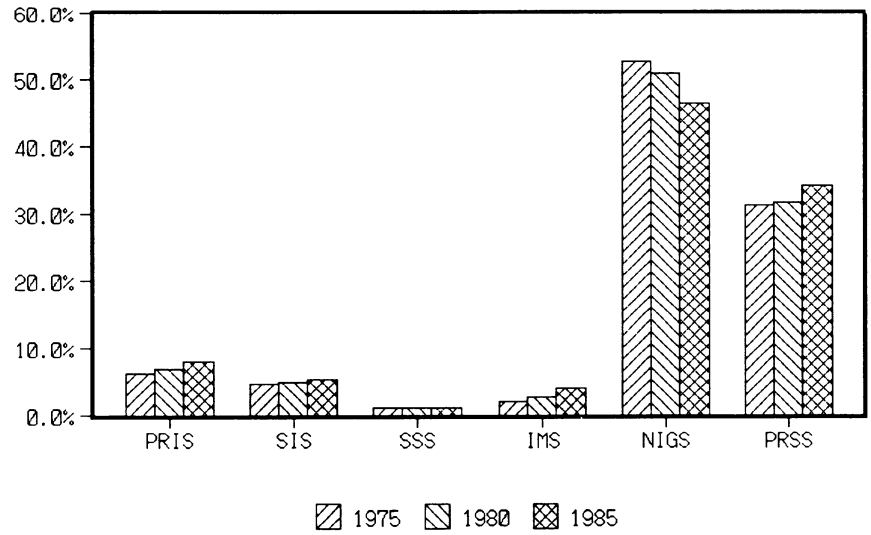


Figure 3-1-2 Total output structure

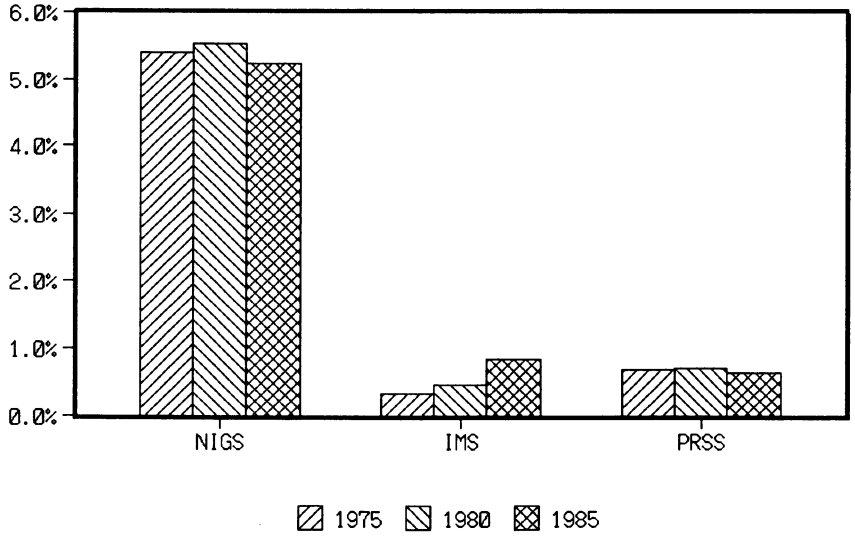


outputs of **SIS** by each sector. Although we suggest that the ratio of value added and total output of **SIS** have been rising, there are differences between **SIS** sub-sectors. From figure 3-1-3, we can confirm the increase of the share of value added in **SIS2** and the decrease of those of **SIS1**. This is reflective of the change in industrial structure alluded to in the previous section.

3-2 The performance of the input structure

Uno (1989) divides the economy into manufacturing and service sectors and shows the changing structure of intermediate inputs to each industry. He shows that the input share of

Figure 3-1-3 Value-added structure of the secondary information sector



the manufacturing sector in the total economy exhibits steady increase from about 1955 to 1970 but that the trend has been reversed since 1970. Furthermore, he suggests that the services as intermediate inputs have gained importance. Although our classification includes the **SIS** and **SSS**, we aggregate the **PRIS, PRSS, SIS** and **SSS** into non-goods sectors which correspond to service sectors Uno (1989) suggests. We also aggregate the **NIGS** and **IMS** into goods sectors which correspond to Uno's manufacturing sectors. These are not input coefficients. The figures in table 3-3 are ratios of each industry to total intermediate demand. They

Table 3-3 Structure of intermediate inputs by sectors (unit: ratio)

	1975	1980	1985
Goods	0.602	0.599	0.551
Non-Goods	0.370	0.377	0.430

Table 3-4 Structure of intermediate inputs by sub-sectors (unit: ratio)

non-goods

	1975	1980	1985
NIGS	0.3857	0.3811	0.3661
IMS	0.0131	0.0126	0.0183
PRIS	0.1940	0.1799	0.2265
SIS1	0.0000	0.0000	0.0000
SIS2	0.0000	0.0000	0.0000
SIS3	0.0497	0.0528	0.0461
PRSS	0.3146	0.3255	0.3199
SSS1	0.0000	0.0000	0.0000
SSS2	0.0000	0.0000	0.0000
NC	0.0429	0.0481	0.0231
SUM	1.0000	1.0000	1.0000

goods

	1975	1980	1985
NIGS	0.6673	0.6688	0.6116
IMS	0.0107	0.0117	0.0175
PRIS	0.0258	0.0303	0.0393
SIS1	0.0992	0.1007	0.1116
SIS2	0.0081	0.0111	0.0240
SIS3	0.0000	0.0000	0.0000
PRSS	0.1371	0.1320	0.1455
SSS1	0.0286	0.0261	0.0306
SSS2	0.0011	0.0018	0.0030
NC	0.0221	0.0175	0.0169
SUM	1.0000	1.0000	1.0000

Table 3-5 Structure of intermediate inputs by sector (unit: ratio)

3-5-a

1975Year	NIGS	IMS	PRIS	SIS1	SIS2	SIS3	PRSS	SSS1	SSS2	NC	SUM
NIGS	0.6733	0.5098	0.3346	0.3752	0.3763	0.3409	0.3915	0.4115	0.3512	0.5532	0.5906
IMS	0.0099	0.0315	0.0119	0.0136	0.0152	0.0136	0.0126	0.0121	0.0158	0.0190	0.0114
PRIS	0.0253	0.0403	0.3741	0.2652	0.2518	0.3183	0.1293	0.1224	0.1381	0.0560	0.0662
SIS1	0.1030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0710
SIS2	0.0000	0.2213	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0058
SIS3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0726	0.0000	0.0000	0.0000	0.0136
PRSS	0.1363	0.1578	0.2138	0.2641	0.2729	0.2503	0.3541	0.4080	0.4448	0.3718	0.1919
SSS1	0.0297	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0205
SSS2	0.0000	0.0298	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008
NC	0.0226	0.0095	0.0656	0.0819	0.0838	0.0769	0.0399	0.0461	0.0501	0.0000	0.0282
SUM	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

3-5-b

1980Year	NIGS	IMS	PRIS	SIS1	SIS2	SIS3	PRSS	SSS1	SSS2	NC	SUM
NIGS	0.6779	0.4874	0.3417	0.3779	0.3879	0.3422	0.3963	0.4205	0.3828	0.5360	0.5862
IMS	0.0108	0.0306	0.0136	0.0151	0.0167	0.0149	0.0127	0.0114	0.0161	0.0359	0.0128
PRIS	0.0297	0.0429	0.3597	0.2571	0.2579	0.3181	0.1491	0.1429	0.1592	0.0724	0.0771
SIS1	0.1057	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0699
SIS2	0.0000	0.2319	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0077
SIS3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0690	0.0000	0.0000	0.0000	0.0139
PRSS	0.1318	0.1355	0.2243	0.2746	0.2627	0.2555	0.3382	0.3851	0.3979	0.3558	0.1890
SSS1	0.0275	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0181
SSS2	0.0000	0.0365	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012
NC	0.0166	0.0352	0.0608	0.0752	0.0747	0.0692	0.0347	0.0401	0.0441	0.0000	0.0241
SUM	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

3-5-c

1985Year	NIGS	IMS	PRIS	SIS1	SIS2	SIS3	PRSS	SSS1	SSS2	NC	SUM
NIGS	0.6300	0.4009	0.3114	0.3531	0.3657	0.3036	0.3813	0.4014	0.3321	0.5205	0.5332
IMS	0.0143	0.0551	0.0198	0.0228	0.0237	0.0207	0.0174	0.0156	0.0210	0.0445	0.0181
PRIS	0.0378	0.0556	0.4006	0.2748	0.2378	0.3761	0.1784	0.1687	0.1814	0.1602	0.0997
SIS1	0.1213	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0751
SIS2	0.0000	0.2987	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0161
SIS3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0648	0.0000	0.0000	0.0000	0.0145
PRSS	0.1467	0.1311	0.2291	0.2977	0.3150	0.2560	0.3426	0.3960	0.4435	0.2748	0.2020
SSS1	0.0333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0206
SSS2	0.0000	0.0375	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020
NC	0.0165	0.0211	0.0391	0.0515	0.0578	0.0437	0.0156	0.0183	0.0220	0.0000	0.0186
SUM	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 3-6 Share of **PRIS** as intermediate inputs to **NIGS** and **IMS**

(unit : ratio)

	1975		1980		1985	
PRIS	**NIGS**	**IMS**	**NIGS**	**IMS**	**NIGS**	**IMS**
publishing and printing	0.0019	0.0003	0.0019	0.0003	0.0016	0.0006
real estate agencies	0.0006	0	0.0006	0	0.0006	0.0001
communication and broadcasting	0.0018	0.0025	0.0017	0.002	0.001	0.0003
education and research	0.0034	0.0111	0.0039	0.0143	0.0068	0.0275
business service	0.0096	0.0117	0.0127	0.0123	0.0155	0.0092

confirm that the input share of goods sector has been decreasing while that of the non-goods sectors has been increasing. This tendency is comparable with the results Uno (1989) derived. However, since our classification of non-goods sectors include the **SIS** and **SSS** in the **NIS**, the share of non-goods sectors we calculate is larger than that of Uno (1989).

Table 3-4 summarizes the input share of each goods sector and non-goods sector. Within the goods sectors, the share of **NIGS** as intermediate inputs have declined and the share of **IMS** as intermediate inputs have increased. This tendency is due to the change in industrial structure as Uno (1989) pointed out. Furthermore, the share of **PRIS** and **PRSS** as intermediate inputs has been rising. This shows the increase of information and service inputs in other sectors. He shows the rise of "softization" as the increase of non-goods inputs to the total economy. However, in the goods sectors the share of **PRSS as intermediate inputs to IMS** have been decreasing and the share of **SSS2** as intermediate inputs to **IMS** have been increasing (see table 3-5). This illustrates that the **IMS** buys more service inputs from itself than **PRSS** (due to our assumption that the **SIS** and **SSS** only sell to original sectors to which belong, the increase of **SIS** and **SSS** as intermediate inputs indicates that the increase of the ratio that proper sectors buy the information inputs and service inputs from the intra sectors).

Moreover, we can confirm that the shares of **SIS1** and **SIS2** as intermediate inputs have been expanding. This stands for the increase of the ratio that the **NIGS** and **IMS** buy information inputs from themselves. Thus, since the shares of intermediate inputs to **NIGS** and **IMS** from both **PRIS** and **SIS** exhibit increasing trends, these sectors buy information inputs from within and without. In table 3-4 within the non-goods sectors, we can confirm the share of **PRIS** and **PRSS** to non-goods sectors is higher than the those of goods sectors. In particular, the shares of **PRIS** as intermediate inputs to the **PRSS** and **SIS3** have been increasing (see table 3-5). This suggests that "softization" in the non-goods sectors proceeded more rapidly than those in goods sectors.

In our analysis, we summarize the input structure incorporating the **SIS** and **SSS** in detail based on the analysis in Uno (1989). We find that the share of **PRIS** and **PRSS** as intermediate inputs have been increasing in the most sectors. In particular, we can show the increase of the business service and education and research as intermediate inputs in the **NIS** (see table 3-6). Although Porat and Rubin (1977) don't calculate inputs to the **NIS** from the **PRIS**, the increase of **PRIS** as the intermediate inputs should be stressed since it is the principal indicator

of the "softization". Furthermore, the shares of **IMS** as intermediate inputs to **SIS** have risen. Also, the **NIGS** and **IMS** shares gradually increased in recent years. This implies that the input structures of the **NIS** and **SIS** have been rising interdependently.

4. Concluding remarks

We obtained the following results. First, we can confirm that the size of **PRIS** and **SIS** increased during 1975-85. Although the size of **SIS** is smaller than indicated by other studies, this is due to methodological differences used to derive **SIS**. By using our method, we can estimate the different wages of each occupation by industry. They seem to reflect the system of wages in recent years. Second, we can see that the share of **PRIS** as intermediate inputs to the **NIS** have been rising. In particular, the share of business services and education and research as intermediate inputs have grown. This reflects an increase in "softization" and information orientation. Third, we observe an increase of **IMS** as intermediate inputs as well as these of **PRIS** and **PRSS**. Finally, because we have constructed a reconstituted input-output table which incorporates **SIS** and **SSS**, we can analyze the domestic products induced by individual final demand items by using this table in future research.

1) I am grateful to Kiyoshi Fujikawa, Koichi Futagami, Shingo Ishiguro, Jim Raymo and Hiroshi Yamada for useful comments and discussions. I also benefitted from the suggestions of Lawrence Klein, F. Gerad Adams, Masahiro Kuroda, Gosei Ohira and Mitsuo Saito. All remaining errors are mine.

2) See Handbook of financial data of industries (1976, 1981, 1986, 1990) and Economic report of the president (1994).

3) Engelbrecht (1986), Karunaratne (1986) and Stäglin (1986) use the classification of the information industries based on the International Standard Industrial Classification (**ISIC**) of OECD.

4) R. Stone (1962) adopts "the commodity technology assumption" rather than "the industry technology assumption" in which the input coefficients of the industry are the same regardless of commodity. See also Miyazawa (1966) and Kaneko (1971).

5) The other method to remove minus inputs is as follows:

1, Set the negatives to zero.

2, Recalculate only columns which include negative coefficients (R. Stone (1962)). See Gigantes (1969) and Norbert (1989).

6) Since we don't consider the number of information workers and service workers by classifying sex and firm size, it seems that the figures are overestimated (underestimated). However, our results approximately show the difference of wages of occupations by industry.

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