COMPARATIVE INPUT-OUTPUT ANALYSIS OF THE INFORMATION INDUSTRIES OF SHANGHAI AND TOKYO[1]

Guoping Mao
School of International Business, Shanghai University, 211, Lian Hua Road, Shanghai, 200233, P.R.China.

Yoshiro Higano
Institute of Agriculture and Forest Engineering, University of Tsukuba, Tennoudai 1-1-1, Tsukuba 305, Japan.

ABSTRACT This paper attempts to analyze the industrial characteristics of the information industries by means of the input-output model. By comparing, we highlight the function of information industries in a developing metropolis such as Shanghai and a highly developed metropolis such as Tokyo, and point out the structural differences between them. The impact of the information industries on the socio-economy differs greatly between Shanghai and Tokyo.

1. INTRODUCTION

Presently the world is undergoing an information revolution with astonishing speed. Understanding the impact of the information industry on the socio-economy is an important issue. It was Machlup (1962) who first took account of information activity as an industry in the U.S. economy. Porat (1977) carried out an input-output (IO) analysis of U.S. information industries. Subsequently, studies of the information economy in other developed countries were also carried out, for example, Canada, Japan, the UK, (Komatuzaki, 1980; Hepworth, 1986; OECD, 1986; Howells, 1987; Coffey and Polese, 1989; Goe, 1990; O'Farrell and Hitchens, 1990; Coffey and Bailly, 1991; Noyelle and Peace, 1991; Porterfield and Pulver, 1991;Wood, 1991; Marshall and Wood, 1992; Hansen, 1994; Amirahmadi and Wallace, 1995; Lakshmanan and Okumura, 1995). All these studies have provided substantial evidence of the processes and the trends of the information-oriented economy in developed countries, and have shown the impact of information industries on regional development, as well as features in information-oriented production. However, there are very few studies on this phenomenon in developing countries.

This paper attempts to analyze the Shanghai information industries as an example for the case of a developing metropolis by means of input-output (IO)

---

[1] We thank two anonymous reviewers for their very useful comments towards improving a previous version of this paper.

methods. We also compare the Shanghai information industries with those of Tokyo. This comparison highlights the difference of function of the information industries between Shanghai and Tokyo.

2. THE INFORMATION INDUSTRY AND INPUT-OUTPUT TABLE

The information industries are those that create, produce, dispose-off, teach, deliver, and provide knowledge, information, data, and messages. In this study, based on Machlup's (1962) and Porat's (1977) classification, the information industries are defined as shown in Table 1. We should add that in Table 1, although some sectors include obviously non-information industrial activities, based on the technological assumption of the IO model, industries belong to either the information sector or the non-information sector.

The non-information sectors follow Table 1. Sectors (11) to (18) can be considered as information-related industries. These sectors produce information equipment and information-related materials that are necessary for information activities.

Table 1. Information Industries

Information Industries	Description
(1) Research	Natural Science Research Institutes, Social Science Research Institutes, Interdisciplinary Research Institutes.
(2) Education	Universities, Colleges, Technical Schools, Middle Schools, Primary Schools, Kindergartens
(3) Broadcasting & Publishing	Publishing Houses, News Agencies, Magazine Publishers, Libraries, Cinemas, Museums, Cultural Centers, Art Galleries, Broadcasting Stations
(5) Banking & Insurance	Banks, Credit Cooperatives, Trust Companies, Insurance Companies
(6) Public Services	Government Organiszations, Social Institutions, Legal Services, Public Arrairs Services.
(7) Post and Telecommunications	Postal and Telecommunication Offices
(8) Estate Arbitration	Estate Arbitration Houses, Estate Management Houses
(9) Advertising	Advertising Agencies, Radio and Television Advertising, Publishing Houses Advertising
(10) Information Services	Information Services Corporation, Investigation Corporation

(11) Computers
(32) Household Appliances
(13) Electrical Acoustics
(14) Communication Facilities
(15) Precision Instruments
(16) Paper Manufacture
(17) Printing
(18) Office Stationery
(19) Agriculture
(20) Mining
(21) Food Manufacture
(22) Fabrics & Textiles
(23) Wood Products
(24) Electricity
(25) Petroleum Refining
(26) Coke
(27) Chemical Products
(28) Building Materials
(29) Iron & Steel
(30) Metal Processing
(31) Machine Equipment
(32) Facilities for Transportation
(33) Electrical Appliances
(34) Miscellaneous Industries
(35) Construction
(36) Transportation of Goods
(37) Trade
(38) Catering
(39) Transportation of Passengers
(40) Real Estate
(41) Public Utilities

We obtained 1987 IO data for Shanghai from the Shanghai Statistics Bureau, the Peoples Republic of China. The estate arbitration, advertising, and information services sectors are not included in the Shanghai IO statistics because there were no such sectors at that time in Shanghai. We obtained 1990 IO data for Tokyo from the Statistics Department, Management and Coordination Bureau of the City Government of Tokyo, Japan.

Shanghai is the largest economic center in China, and has had a history of industrialization for a century. Before 1980, the Shanghai economy was part of a centrally planned economic system; industrial development was directly and strongly controlled by industrial policy. Before 1950, the Shanghai economy was driven by light industries with low technology and productivity. During the 1950s and 1960s, the industrial policy focused on heavy industries. In the 1970s, in order to redress the unbalanced structure, new investment was spread over light industries and heavy industries. From the 1980s, the industrial policy began to attach importance to the service industries and the information industries.

In Tokyo, the information industries developed much earlier. Especially from the later 1960s, the increasing expenditure on R&D and education, the outfitting of information infrastructure, and the fostering of talented persons, have greatly promoted the development of information industries. Without question, Tokyo is quite advanced in the economic structure, which Shanghai is in its early development stages.

3. ECONOMIC AND PRODUCTIVE STRUCTURE

Economic activity is an input-output activity. In the IO model, the total output equals the sum of intermediate goods and final goods, the total input equals the sum of intermediate input and value added. We calculated the ratios of intermediate input (which consists of information input and non-information input) and value added (which consists of labour cost and profit) of information industries and non-information industries to the total input as shown in Table 2.

Table 2. The Economic Structure of Shanghai and Tokyo (Percentage)

	Shanghai			Tokyo		
	Information Industry	Non-Information Industry	Total	Information Industry	Non-Information Industry	Total
Intermediate Input	1.8	61.0	62.8	13.5	32.5	46.0
Information	0.1	2.3	2.4	7.1	7.1	14.2
Non-Information	1.7	58.7	60.4	6.4	25.4	31.8
Value Added	3.6	33.6	37.2	16.8	37.2	54.0
Labour Cost	0.8	7.2	8.0	11.0	19.3	30.3
Profit & Other	2.8	26.4	29.2	5.8	17.9	23.7
Total	5.4	94.6	100.0	30.3	69.7	100.0

In Shanghai, the ratio of information products to the total output is only 5.4 percent, and in Tokyo it amounts to 30.3 percent. The position of the information industries in the entire production is clearly different. The average rate of intermediate input of all the industries for Shanghai is 62.8 percent whereas for Tokyo it is only 46.0 percent. The gap is 16.8 percentage points. It shows that the rate of value added in the entire production in the Tokyo industries is higher than that of the Shanghai industries by 16.8 percentage points. With respect to the total output in Tokyo, about one third of value added is from the information industries (16.8 percent, 54.0 percent), and in Shanghai, only about one tenth of value added is from the information industries (3.6 percent, 37.2 percent). The ratio of information input of Shanghai to the total input is only 2.4 percent, and that of Tokyo is 14.2 percent. In Shanghai, the ratio of information input to non-information input is about 1:25 (2.4 percent, :60.4 percent). In Tokyo, it is about 1:2.3 (14.2 percent:31.8 percent).

The input content and the input structure are totally different. In Shanghai, 0.04 units of information input is bound to follow one unit of non-information input (2.4 percent, 60.4 percent), and in Tokyo, 0.45 units of information input is bound to follow one unit of non-information input (14.2 percent, 31.8 percent). It appears that Tokyo has a significant amount of information input in its production. There is a difference of 11 times (0.45/0.04) in the information input between Shanghai and Tokyo. In Tokyo, high information input is combined with low non-information input. Tokyo's non-information input is only 31.8 percent of its total input. In contrast, Shanghai's non-information input accounts for 60.4 percent in its total input due to its very low information input. In Shanghai, because of the low information input, the production lacks new knowledge and advanced technology, and so it has a high intermediate consumption (62.8 percent). In Tokyo, because of high information input, the production uses a volume of new knowledge and advanced technology, and so overall, it has a low intermediate consumption (46.0 percent). Information industries provide an "intermediate function that serves as

Table 3. The Productive Structure of Shanghai and Tokyo. (Percentage)

	Shanghai			Tokyo		
	Information Industry	Non-Information Industry	Total	Information Industry	Non-Information Industry	Total
Intermediate Input	32.9	64.5	62.8	44.8	46.6	46.0
Information	2.4	2.4	2.4	23.6	10.2	14.2
Non-Information	30.5	62.1	60.4	21.2	36.4	31.8
Value Added	67.1	35.5	37.2	55.2	53.4	54.0
Labour Cost	15.1	7.6	8.0	36.2	27.7	30.3
Profit & Other	51.9	27.9	29.2	19.0	25.7	23.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

inputs into the production of goods or other services. They enhance the efficiency of operation and the value of outputat various stages of the production process" (Hansen, 1994). Results from Tokyo imply that information and information services are "becoming increasingly important inputs to the economy's processes of production" (Noyelle and Peace, 1991). The production system is characterised by higher than average information content. The higher the information input, the higher the value added. Information is a strong productive force, "its impact is not limited to spatial organization of industries as it also attends production methods" (Amirahmadi and Wallace, 1995), which is confirmed again by the Tokyo production mode and structure.

The ratios of intermediate inputs and value added of the information and non-information industries to their total inputs respectively, are shown in Table 3. In the case of Tokyo, the subdivision of the intermediate input indicates that the input structure of the information industry is contrary to that of the non-information industry. Information input represents the largest share for the information industry, and non-information input for the non-information industry, the different input structure between information industries and non-information industries clearly highlights the "information" feature of information industry. which inputs a lot of information, then creates and processes additional information. However, the Shanghai information industry differs from that of Tokyo. For the Shanghai information industries, only 0.08 units of information input are bound to follow one unit of non-information input (2.4 percent, 30.5 percent). For the Tokyo information industries, 1.11 units of information input are bound to follow one unit of non-information input (23.6 percent, 21.2 percent). So, we see that in the information production, corresponding to one unit of non-information input, the information input of Tokyo is about 14 times larger than that of Shanghai (1.11/0.08). Similarly, in non-information production, the information input of Tokyo is 7 times larger than that of Shanghai. That illustrates the different input features of each industry in Shanghai and Tokyo. The Tokyo information

industries have changed the mode of production and have greatly transformed their economic structure. The information industries "participate in different ways in structural change" (Marshall and Wood, 1992), and are forming a highly information-oriented economy, with high productivity, advanced technology, and a strong information impact.

With respect to the subdivision of value added, both the information industries and the non-information industries in Shanghai have a high profit rate because of the very small share of labour cost. In Tokyo, the labour cost for either the information industries or the non-information industries is very large. This feature is the same as that in other developed countries or regions, for example, the U.S. information industries have a large labor cost component (Hansen, 1994; Porterfield and Pulver, 1991). Their profits are gained by low intermediate input. The structure of value added for the Shanghai industries and the Tokyo industries is quite different.

In summary, the intermediate input structure and the value added structure show that, between Shanghai and Tokyo, the composition of production are greatly different. Depending on information and information activities, the Tokyo economy has a low intermediate consumption and a high value added rate. Because of low information input, the Shanghai economy has a high intermediate consumption, and a low value added rate.

4. PROPOSITIONS

Such differences in economic structure and productive structure exist between a developing metropolis such as Shanghai and a highly developed metropolis such as Tokyo. That attributes to some internal causes, namely, the differences in industrial nature, industrial feature, and industrial function for the Shanghai information industries and those of Tokyo. We find that the Tokyo information sectors have an information-oriented economy, and illustrate the extent that information sectors play in the economy. Here, we put forward three propositions to further interpret why the economic structure and productive structure are different between Shanghai and Tokyo.

Proposition 1

In a highly developed metropolis like Tokyo, the information industry is in quite advanced stages where information sectors have the nature of creativeness, originality, and leadership. In an early development metropolis like Shanghai, the information industry is in early development stages where information sectors are lacking in the areas as those of Tokyo.

Proposition 2

In the highly developed Tokyo metropolis, information industries are closely linked with non-information industries, and are easily affected by total production.

The Tokyo production has a great amount of information demand. In the early development of the Shanghai metropolis, information industries are not closely linked with non-information industries, and the demand for information is weak.

Proposition 3

In Tokyo, information and information services have become an indispensable productive force. Information industries perform a strong function to its total production. In an early development metropolis such as Shanghai, information and information services have not become a strong productive force, resulting in the impact of information industries on total production being weak.

In the following sections, we attempt to verify those propositions by using input-output analysis.

5. VERIFYING PROPOSITION 1

First, we use purchases and sales coefficients, and internal and external multipliers to verify proposition 1. Purchases and sales coefficients measure the direct impact on the purchases and sales of intermediate goods of each sector. Purchases coefficient, $PC_j(i)$ and sales coefficient, $SC_i(j)$ are calculated as follows:

$$PC_j(i) = \frac{x_{ij}}{\sum_{i=1}^{N} x_{ij}}, \quad i, j = 1,2,\cdots,N \tag{1}$$

$$SC_i(j) = \frac{x_{ij}}{\sum_{j=1}^{N} x_{ij}}, \quad i, j = 1,2,\cdots,N \tag{2}$$

where x_{ij} is the quantity of goods which sector j purchases from sector i, $\sum_{i=1}^{N} x_{ij}$ represents total purchases of intermediate goods by sector j, and $\sum_{j=1}^{N} x_{ij}$ represents total sales of intermediate goods by sector i.

Based on the calculated results of purchases and sales coefficients of the information industries for Shanghai and Tokyo, we know that the Shanghai information industries purchase goods mainly from the printing, chemical products, transportation of goods, building materials, trade, petroleum refining and communication facilities sectors. Most of those goods can be labeled as "hard" goods. Those goods are relatively important for the development of the Shanghai information industries at present. The industries which directly and immediately

affect the Tokyo information industries are mainly information services, broadcasting and publishing, post and telecommunication, advertising, banking and insurance, printing, public utilities, and so on. Most of those goods can be labelled as "soft" goods. Comparing the purchase coefficients of Shanghai and Tokyo, it is clear that the Shanghai information industries are under construction. Hence, they purchase "hard" goods. However, the Tokyo information industries are engaging in information activities. Hence, they purchase "soft" goods - knowledge, technology, information, data. Clearly, the Shanghai information industries and the Tokyo information industries are at different stages. Due to this "softness", Tokyo is similar to other developed regions, that is, the distinction between the information industries and non-information industries "has become increasingly blurred" (Howells 1987).

We see from the sales coefficients that the relatively important customers for the Shanghai information industries are trade, machinery equipment, research and construction areas. In Tokyo, the main customers are public utilities, information services, trade, broadcasting and publishing, banking and insurance, advertising, construction and communication facilities areas. By comparing sales coefficients, we find that the direct impact of the Tokyo information industries is much broader than that of Shanghai.

In general, purchases and sales coefficients show that, the Tokyo information industry is in a highly soft-oriented stage and the "soft" goods are important for its development. But, the Shanghai information industry is in an industrial formation stage and the "hard" goods are important for its development.

We use the concepts of internal and external multipliers (Miyazawa 1966, Miller and Blair 1985) for further analysis and denote the information and non-information industries by using the suffixes *I* and *N*. Therefore, the basic IO model can be decomposed as follows.

$$\begin{pmatrix} X_I \\ \cdots \\ X_N \end{pmatrix} = \begin{pmatrix} A_{II} & : & A_{IN} \\ \cdots & \cdots & \cdots \\ A_{NI} & : & A_{NN} \end{pmatrix} \cdot \begin{pmatrix} X_I \\ \cdots \\ X_N \end{pmatrix} + \begin{pmatrix} F_I \\ \cdots \\ F_N \end{pmatrix} \tag{3}$$

also,

$$\begin{pmatrix} X_I \\ \cdots \\ X_N \end{pmatrix} = \begin{pmatrix} I - A_{II} & \vdots & -A_{IN} \\ \cdots & \cdots & \cdots \\ -A_{NI} & \vdots & I - A_{NN} \end{pmatrix}^{-1} \cdot \begin{pmatrix} F_I \\ \cdots \\ F_N \end{pmatrix}. \tag{4}$$

We denote $B_{II} = (I - A_{II})^{-1}$ the internal multiplier of information industries, and $B_{NN} = (I - A_{NN})^{-1}$ the internal multiplier of non-information industries. The internal multiplier means that the intersectoral feedback effects are formed through its own productive activities within each sector. The intersectoral feedback formed

from the B_{II} and B_{NN} can be expressed as four rectangular sub-multipliers: $B_1(=A_{NI}B_{II})$ $B_2(=B_{II}A_{IN})$ $T_1(=A_{IN}B_{NN})$ and $T_2(=B_{NN}A_{NI})$.

These sub-multipliers show the coefficients of induced effects on products due to the input-output relation between information industries and non-information industries. If we select B_2 and T_2 as the base for these intersectoral multipliers, we could define the external multipliers L of information industries and the external multipliers K of non-information industries, as follows:

$$L = (I - B_2 T_2)^{-1}$$

and

$$K = (I - T_2 B_2)^{-1}$$

The external multiplier means that the direct and indirect effects are formed through the production of other sectors. Hence, we know that the total repercussion effect on information industries and non-information industries, each generated by their multipliers, are expected to take the value LB_{II} and KB_{NN} respectively. Based on the above notation, we can decompose the Leontief inverse into the internal and external multipliers and the induced sub-multipliers as follows.

$$B = (I - A)^{-1} = \begin{pmatrix} B_{II} + B_2 K B_{NN} B_1 & \vdots & B_2 K B_{NN} \\ \cdots & \cdots & \cdots \\ K B_{NN} B_1 & \vdots & K B_{NN} \end{pmatrix} \quad (5)$$

For analysis, we use the concept of the multiplier ratio as follows :

$$\text{Multiplier ratio} = \frac{\text{Internal multiplier}}{\text{External multiplier.}}$$

It is clear that if the multiplier ratio is greater than 1 for sector *i*, the production of sector *i* is mainly derived from its own activities Conversely, the production of sector *i* is mainly derived from other sectors. The calculated results are presented in Table 4 (the non-information sectors are omitted here).

As shown in Table 4, the multiplier ratios of the Shanghai information industries are all less than 1, except for the broadcasting and publishing sector. This suggests that the repercussion effect from information activities inside the Shanghai information sectors is weak. However, the multiplier ratios of most of the Tokyo information industries are larger than 1, except for education, medical and health care, and public services. This suggests that the repercussion effect from information activities inside the Tokyo information sectors is strong. The information industries strongly "provide an internal service" (Howells, 1987). Information production is mainly dependent on its own activities.

Table 4. The Multiplier Ratio

Industries	Multiplier Ratio		Industries	Multiplier Ratio	
	Shanghai	Tokyo		Shanghai	Tokyo
1. Research	0.84	1.06	6. Public Services	0.72	0.86
2. Education	0.70	0.87	7. Post & Telecommunications	0.85	1.03
3. Broadcasting & Publishing	1.30	1.94	8. Estate Arbitration	N.S.*	1.50
4. Medical & Health Care	0.42	0.69	9. Advertising	N.S.*	2.34
5. Banking & Insurance	0.94	1.33	10. Information Services	N.S.*	1.30

* N.S.: not in statistics.

Information activities exhibit creativeness, originality, and leadership. The multiplier ratios testify that the Tokyo information industries have those features to a large extent; the Shanghai information industries, however, do not apparently have the creativity, originality, and leadership features as those of Tokyo.

6. VERIFYING PROPOSITION 2

Now, we use coefficients of induced production, and coefficients of the power of dispersion and the sensitivity of dispersion to verify proposition 2. The basic IO output equation implies that total output is induced by final demand sales. Based on this, we can calculate the production induced by consumption, investment, exports, and shipment to region.

The ratios of the induced production by one type of the final demand to aggregate final demand of this type are called coefficients of induced production for this final demand. Coefficients of the induced production tells us how much production is induced to be produced by one unit of final goods (Miyazawa, 1991). By these coefficients, we can judge the induced impact of the final demand towards production of each industry. Coefficients of the induced production in Shanghai and Tokyo are reported in Table 5.

Table 5. Coefficients of the Induced Production for Final Demand

Coefficient	Consumption		Investment		Export		Shipment to Region*	
Industry	Shanghai	Tokyo	Shanghai	Tokyo	Shanghai	Tokyo	Shanghai	Tokyo
Information	0.267	0.488	0.069	0.238	0.299	0.413	0.075	0.598
Non-Information	2.054	1.328	2.678	1.887	2.497	1.763	2.541	1.374
Total	2.321	1.816	2.747	2.125	2.796	2.176	2.616	1.972

* Export from Shanghai/Tokyo to other regions in China/Japan.

From Table 5, we see that, the difference of the coefficients between the information industry and the non-information industry is large for Shanghai and relatively small for Tokyo. The difference in the coefficient of consumption for Shanghai is 1.787 (2.054-0.267), but for Tokyo it is only 0.840 (1.328-0.488). The difference in the coefficient of investment for Shanghai is 2.609 (2.678-0.069), but for Tokyo it is 1.649 (1.887-0.238). The difference in the coefficient of export for Shanghai is 2.198 (2.497-0.299), but for Tokyo it is 1.350 (1.763-0.413). The difference in the coefficient of interregional shipment for Shanghai is 2.466 (2.541-0.075), but for Tokyo it is 0.776 (1.374-0.598). These differences show that, in a developed metropolis such as Tokyo, information goods and information services are closely linked with total production; information industries and non-information industries interact with each other in the production system. Consequently, the induced effect of a change in the final demand has repercussion effects on information industries and non-information industries alike. In Shanghai, it seems that the link of information activities with non-information activities in total production is not so close. When the induced impact of the final demand on the non-information industries is strong, the induced impact on the information industries is not simultaneously strong. This is due to the difference in the nature of the information industries in Shanghai and Tokyo.

For the Shanghai information industries, the coefficient of investment is very small (0.069) compared with the coefficients of consumption (0.267) or export (0.299). But for the Tokyo information industries, the coefficient of investment (0.238) is large compared with the coefficient of consumption (0.488), export (0.413), or shipment to regions (0.598). Investment is a process of capital formation. Information investment makes "service expertise more widely and quickly available", information production has "of course, been affected significantly by technological change, most obviously by high speed, large capacity information processing and communication technologies and new modes of transportation" (Wood, 1991). By comparing the coefficients of investment between Shanghai and Tokyo, we find that as Tokyo is moving rapidly towards the information-oriented economy, information investment is growing accordingly. As a result, total investment may yield a significant amount of information demand and information production. In Shanghai, where it seems there is still a process of industrialization taking place, there is a strong demand for investment in non-information goods. Consequently, total investment has led to a significant level of non-information production.

For further analysis, we use coefficients of the power of dispersion and the sensitivity of dispersion which use the Leontief inverse matrix B with elements b_{ij} (Rasmussen, 1956; Hazari, 1970). The coefficient of the power of dispersion (CPD) is calculated as follows:

$$CPD_j = \frac{\frac{1}{N}\sum_{i=1}^{N} b_{ij}}{\frac{1}{N^2}\sum_{i=1}^{N}\sum_{j=1}^{N} b_{ij}}, \quad j = 1,2,\ldots,N \tag{6}$$

if $CPD_j < 1$, sector j produces only weak output stimuli for the economy; however, if $CPD_j > 1$, this would signal that sector j disperses above-average impulses to other sectors through its intermediate input requirements.

The coefficient of sensitivity of dispersion (*CSD*) is calculated as follows:

$$CPD_i = \frac{\frac{1}{N}\sum_{j=1}^{N} b_{ij}}{\frac{1}{N^2}\sum_{j=1}^{N}\sum_{i=1}^{N} b_{ij}}, \; i, j = 1,2,\cdots,N \tag{7}$$

If $CPD_i < 1$, sector i has a weak sensitivity; and if $CPD_i > 1$, sector i has a strong sensitivity.

Taking the value of 1 as the criterion, we can use this approach to distinguish sectors which disperse strong or weak impulses and those which have strong or weak sensitivity (Rasmussen, 1956, Hazari, 1970). Based on the calculated results, we regroup the Shanghai and the Tokyo information sectors as shown in Table 6.

It can be seen from Table 6 that many of the Shanghai information industries are characterized by both weak impulses and weak sensitivity. Those sectors are research, education, public services, and post and telecommunication. Though the broadcasting and publishing, medical and health care sectors have strong impulses, their products are mainly final goods, not intermediate goods. So, it seems that the Shanghai information industries have loose ties with the other industries and they lack both strong impulses and sensitivity to total production.

The information industries in Tokyo which have both strong impulses and strong sensitivity are broadcasting/ publishing and advertising. We notice that these two sectors are also intermediate goods industries. Besides, research, banking/insurance and the information services industries have strong sensitivity. These sectors are easily affected by total production. As a result, it would appear that the Tokyo information industries are closer to the other industries, and contribute to growth of those sectors. They have strong impulses and sensitivity, information appears very strong and active, "the great majority of industries are linked with other sectors through nonmaterial flows." Information "has had a profound effect, not only through the arrival of a wide variety of new products, but also in the changing nature of a very broad variety of existing products and services, and indeed in many of the functions of most firms" (Lakshmanan and Okumura, 1995).

Table 6. Industrial Features by Coefficients of the Power of Dispersion and the Sensitivity of Dispersion

Classification	Shnghai Industries	Tokyo Industries
Strong Impulses with Strong Sensitivity		(3) Broadcasting & Publishing (9) Advertising
Weak Impulses with Strong Sensitivity	(5) Banking & Insurance	(1) Research (5) Banking & Insurance (10) Information Services
Strong Impulses with Weak Sensitivity	(3) Broadcasting & Publishing (4) Medical & Health Care	
Weak Impulses with Weak Sensitivity	(1) Research (2) Education (6) Public Services (7) Post & Telecommunications	(2) Education (4) Medical & Health Care (6) Public Services (7) Post & Telecommunications (8) Estate Arbitration

All analytical results from coefficients of induced production, and coefficients of the power of dispersions and the sensitivity of dispersion testified that, the Tokyo information industries are closely with non-information industries, information and information services are greatly demanded by total production in Tokyo; however, the Shanghai information industries are not closely linked with non-information industries, the demand for information and information services is weak in Shanghai.

7. VERIFYING PROPOSITION 3

In this instance we use backward and forward linkages to verify Proposition 3. The backward linkage is defined as the ratio of total intermediate inputs to total input. The sector with a high backward linkage coefficient will have a low rate of value added. Vice versa, the rate of value added is high for a sector with a low backward linkage coefficient. The forward linkage is defined as the ratio of total intermediate demand to total demand. The sector with a high forward linkage coefficient may be labelled as an intermediate goods industry. Vice versa, the sector with a low forward linkage coefficient may be called a final goods industry (Chenery and Watanabe, 1958). Based on the calculated results, we rearrange the Shanghai information sectors and the Tokyo information sectors as shown in Table 7.

It can be seen from Table 7 that the Shanghai information industries are all final goods industries, with the exception of banking and insurance. The Shanghai information industries such as research, education, broadcasting and publishing, public service, post and telecommunications, have provided very few information goods or services as input to the other industries. The Shanghai information

Table 7. Industrial Features by Backward and Forward Linkages

Classification	Shanghai Industries	Tokyo Industries
Intermediate Goods Industries with High Intermediate Input		(3) Broadcasting & Publishing (9) Advertising (10) Information Services
Intermediate Goods Industries with Low Intermediate Input	(5) Banking & Insurance	(1) Research (5) Banking & Insurance (7) Post & Telecommunications (8) Estate Arbitration
Final Goods Industries with Low Intermediate Input	(1) Research (2) Education (6) Public Services (7) Post & Telecommunications	(2) Education (4) Medical & Health Care (6) Public Services
Final Goods Industries with High Intermediate Input	(3) Broadcasting & Publishing (4) Medical & Health Care	

industries do not perform a strong function towards total production. Among the Tokyo information industries, there are 7 sectors of intermediate goods industries and 3 sectors of final goods industries. The intermediate goods sectors are research, broadcasting and publishing, banking and insurance, post and telecommunications, estate arbitration, advertising, and information services. Clearly, the majority of the Tokyo information industries provide their information goods and services to the other industries as a productive factor. The information sectors basically are the intermediate goods industries which "act as a process" (Amirahmadi and Wallace, 1995). The information industries are evolving into basic industries of economic development. The growth of the information industries "stimulates a major economic expanse and elevates each metropolitan economy to a higher plateau of economic growth" (Goe, 1989); and "have clearly contributed to development of the flexible production system (Coffey and Bailly, 1991). The Tokyo information industries perform an important function to the total production.

Backward and forward linkages are supported by Proposition 3; in that Shanghai, information have not become a strong productive force. The information industries, in their role as intermediate goods industries, are underdeveloped. In Tokyo, knowledge, data, technology and information services have already become an indispensable productive force, and have a significant impact on the entire production in Tokyo.

8. CONCLUSION

In this study, we find the different input-output structure between a developing metropolis such as Shanghai and the highly developed Tokyo metropolis. Behind the different input-output structure, we feel there exists a different nature, different features, and different functions of information industries (three propositions). These propositions have been testified by using the IO analyses. These analyses have provided a general picture of the impact of the information industries on the total production in Shanghai and Tokyo.

The Tokyo economy has low intermediate consumption and a high value added ratio due to a high information input; but the Shanghai economy has high intermediate consumption and a low value added ratio because of a low information input. The Tokyo information industries are in a highly soft-oriented stage, exhibit the features of strong creativeness, originality and leadership; but the Shanghai information industries are in an industrial formation stage and do not possess such features.

The Tokyo information sectors possess close ties with other sectors in the total production, and contribute towards the growth promotion of other sectors. Information has become an indispensable factor towards production in Tokyo; but the Shanghai information sectors have loose ties with other industries, and do not have a strong effect on the total production in that information has not become a significant productive force. Tokyo is rapidly moving towards the information-oriented economy. Investment yields a high level of information demand and production. However, in Shanghai, investment leads to a significant level of non-information production.

Due to the difference in the input structure, the production modes are totally different between Shanghai and Tokyo. This difference is also the case in the structure of added value, per capita products and per capita income.

REFERENCES

Amirahmadi, H and Wallace, C. (1995). Information technology, the organization of production, and regional development. *Environment and Planning A*, 27: 1745-1775.

Chenery, H.B. and Watanabe, T. (1958) International comparisons of the structure of productions. *Econometrica*, 26: 487-521.

Coffey, W. and Polese, M. (1989) Producer services and regional development: a policy-oriented perspective. *Papers of the Regional Science Association*, 67: 13-27.

Coffey, W. and Bailly, A. (1991) Producer services and flexible production: an exploratory analysis. *Growth and Change*, 22: 95-117.

Goe, W. (1990) Producer services, trade and the social division of labour. *Regional Studies*, 24: 327-342.

Hansen, N. (1994) The strategic role of producer services in regional development. *International Regional Science Review*, 16: 187-195.

Hazari, B.R. (1970) Empirical identification of key sectors in the Indian economy. *The Review of Economics and Statistics*, 52: 301-305.

Hepworth, M. (1986) The geography of technological change in the information economy. *Regional Studies*, 20: 407-424.

Howells, J. (1987) Developments in the location, technology and industrial organization of computer services: some trends and research issues. *Regional Studies* 21: 493-503.

Lakshmanan, T.R. and.Okumura, M. (1995) The nature and evolution of knowledge networks in Japanese manufacturing. *Papers in Regional Science* 74: 63-86.

Machlup, F. (1962) *The Production and Distribution of Knowledge in The United States*. Princeton University Press.

Marshall, J.N. and Wood, P.A. (1992) The role of services in urban and regional development: recent debates and new direction. *Environment and Planning A*, 24: 1255-1270.

Miller, R.E. and Blair, P.D. (1985) *Input-Output Analysis*. Prentice-Hall Inc.

Miyazawa, K. (1966) Internal and external matrix multipliers in the input-output model. *Hototsubashi Journal of Economics*, 7: 38-55.

Miyazawa, K. (1991) An Introduction to Input-output Analysis. (in Japanese). *Japan Economic News publisher.*

Noyelle, T. and Peace, P. (1991) Information industries: New York's new export base. In Daniels, (ed.) *Services and Metropolitan Development: International Perspectives*. Routledge: London.

OECD (1986) Trends in The Information Economy. Organization for Economic Cooperation and Development, Paris.

O'Farrell, P.N. and Hitchens D. (1990) Producer services and regional development: a review of some major conceptual policy and research issues. *Environment and Planning A*, 22: 1141-1154.

Porterfield, S. and Pulver, G. (1991) Exports, impacts, and locations of service producers. *International Regional Science Review*, 14: 41-59.

Porat, M.U. (1977) Information Economy. Vol.1. Definitions and Measurement. Report of the US Department of Commerce. PB-286762.

Rasmussen, P.N. (1956) *Studies in Inter-sectoral Relations*. Amsterdam: North Holland Publishing Company.

Wood, P. (1991) Flexible accumulation and the rise of business services. *Transactions of the Institute of British Geographers*, 16: 160-172.