Dynamic industrial change through the popularization of front-end ICT

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(First tentative draft, not to be quoted)

This study analyzed the Employment Matrix Tables (industrial sectors and occupations) extracted from the linked Input-Output Tables in order to identify the trends of the socio-industrial state of operators and technicians of wireless technology. In contrast with the increasing number of licensees of wireless operators and technicians, the number of in-house operators and technicians started declining rapidly after the 1990s, except within the broadcast industry. This indicates that the popularization of front-end ICT, such as easy-to-use wireless technology, has led to the reduction of the number of the well-qualified and knowledgeable operators and technicians. In the future, new non-professional technicians, who have comprehensive wireless and informatics literacy, will be the core people developing more user-friendly advanced ICT society.

Keywords: Popularization of front-end ICT; User-friendly; Wireless operators and technicians; Advanced ICT society

1. Introduction

We observe contradictory trends between the increasing number of license-holding radio operators or technicians and the decreasing number of in-house wireless communication operators and technicians in mobile service or communication industries except within the broadcast industry.

Where are the radio license holders working?

The answer is that they are working everywhere, but they are not hired as radio operators or technicians. They are the policemen who operate the radar to control traffic circulation, the pilots of airplanes who communicate with the control tower, the first mate of a ship who operates the semi-automatic communication radio system, etc. This indicates that the proliferation of sophisticated front-end ICT incorporated in wireless technology has led to the reduction of well-qualified and skillful communication operators and technicians. Thus, the industries profit from the depression of higher labor costs and this results in changes in industrial structure.

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2. Overview

(1) The diffusion of new ideas which increases social accumulation of knowledge: The popularization of wireless communication technology depends on the degree of awareness and interest among senders and receivers who are not certain that an emerging front-end ICT represents an improvement on the previous skillful technicians, as proposed by Rogers[1] in 1962. It is also worth noting that he states "rejection, discontinuance, and reinvention frequently occur during the diffusion of an innovation[2]".

(2) Popular culture and populist technology: Some types of technology become populist technology. These are well diffused among the younger generation because they utilize them for entertainment in unanticipated ways. This popular culture helps to introduce the next generation, especially amateurs, to a promised market as professionals and/or consumers. This is an idea of Susan J. Douglas[3] (1987) and it is related to the social system of Rogers.

(3) Endogenous technological change: sustainable economic growth is driven only by sustainable improvement in productivity. Only research activity can increase the productivity through the accumulation of human capital and knowledge stock. But the expected return is too small to compensate for the expenditure of maintaining the research activity. Subsidies can encourage this expectation and reduce the expected risk. This is an aspect of the theory of Paul Romer[4] (1990) and Charles I. Jones[5] (1998).

(4) The social role of amateurs: Patrice Flichy[6] (2010) maintains that amateurs play an important social role in creating the emerging culture or new social activities. They establish their expertise outside of professional fields or schools and show their ability to create populist culture, technical performance, practical know-how, political protest, etc.

(5) The social role of unofficial sectors in achieving scientific and technological literacy: Through the observation of the rapid growth of the Japanese electronics industry after the Second World War (World War II), Yuzo Takahashi[7] (2011)

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1 Everett M. Rogers, Diffusion of innovations, p.13, -3rd ed. Free Press, 1983

2 Everett M. Rogers, Diffusion of innovations, p.107, -3rd ed. Free Press, 1983

3 Susan J. Douglas, Inventing American Broadcasting 1899-1922, p.194 l.9-20, Johns Hopkins University Press, 1987

4 Paul Romer, Endogenous Technological Change, S95 and S96 l.23- S97 l.8, Chicago Journals, the Journal of Political Economy, Vol.98, No.5, Part 2, 1990

5 Charles I. Jones, Introduction to economic growth, W.W. Norton & Company, Inc.

6 Patrice Flichy, Le sacre de l'amateur, p.88 l.10-22, Seuil, 2010

7 Yuzo Takahashi, Rajio no rekishi (History of radio), p.333-343, Hosei Daigaku

found that the informal sectors contributed to the development of the emergence of new industries with the cooperation and support of formal sectors. Informal publishing in the chaotic market just after World War II disseminated scientific and technical knowledge and created the enthusiasm for radio technology among young people.

These arguments are persuasive in themselves but weak in two regards:
First, they are not demonstrated by a quantitative model analysis.
Second, they do not address the degeneration or discontinuance process of certain technologies.

3. Working Hypotheses

Our Working Hypotheses are:

(1) The diffusion of front-end ICT devalues highly-trained mono-competence operators or technicians, and opens higher professional opportunities to multi-competence operators or technicians.
(2) The diffusion of front-end ICT encourages the out-sourcing of core competence activities and/or collaboration with informal amateur activities.
(3) The diffusion of front-end ICT results in a reduction of the labor cost and a change in industrial structure.

4. Method

This article aims to show the results of a quantitative analysis model.
We call man-machine interface technology "front-end [8] Information and Communication Technology (ICT)".
To show empirical results with robust data, we use Employment Matrix Tables (101 x 269) to find out the number of wireless radio operators or technicians and system engineers.
To observe changes in industrial structure, we use the Input-Output coefficients matrix and the final demand matrix.
We refer to these data in the Linked Input-Output Tables (1980-1985-1990, 1985-1990-1995, 1990-1995-2000 and 1995-2000-2005).

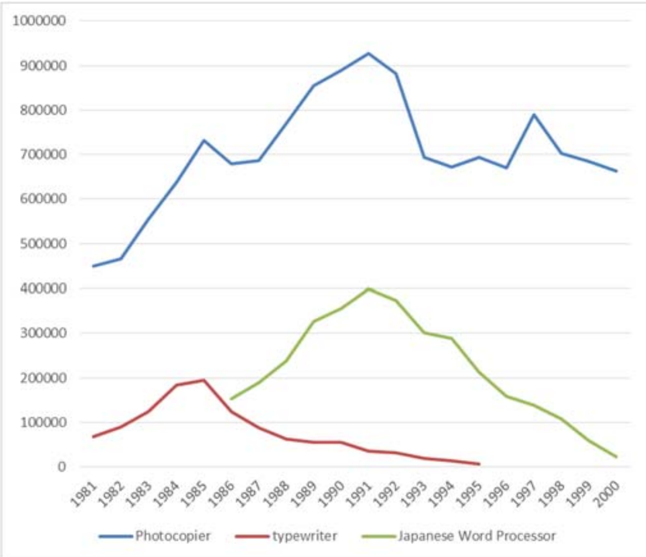
Syuppankai, 2011
[8] This type of man-machine interface technology is called "Front-end" in computer science, such as GUI or Japanese input front end processor, etc.

5. Quantitative analysis model

5.1. Technology Diffusion Model

Fig 1 demonstrates the typical information diffusion process as described by Rogers. We can see a life-cycle model of a technology by a curve expressed here in the number of shipments of a product.

Fig 1. Trends of office machine shipment in Japan (unit: million yen) (1981-2000),



(compiled by the author from Kogyo-Tokei, Industry Census, METI)
<http://www.meti.go.jp/statistics/tyo/kougyo/archives/>

The period of the life-cycle of the Japanese word processor[9] was so short that we can see the whole life-cycle at a glance. But in general, the life-cycle of a piece of technology is much longer. In respect of wireless communication or ICT technology in general, it is difficult to show such a life-cycle curve with the trends of their products shipment because the use of these products started many years ago and is on-going.

We propose using the number of operators or technicians who were licensed or certified by the national government since the emergence of these technologies instead of using the number of shipments of their products.

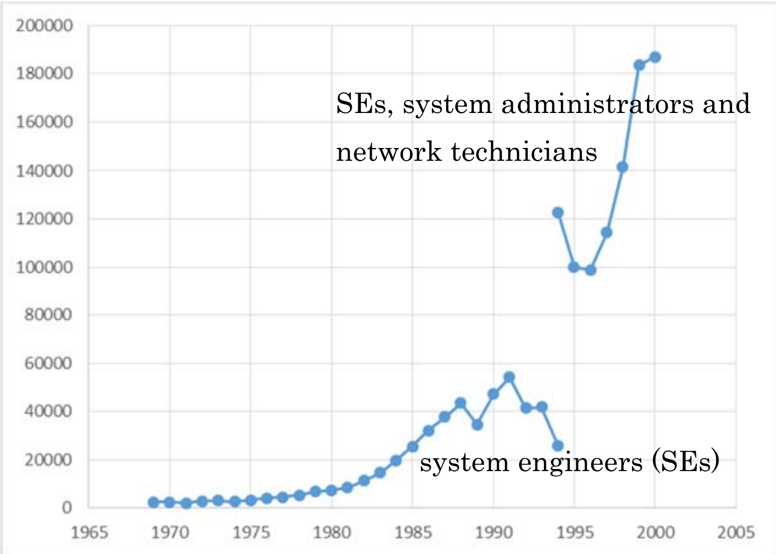
There is a typical example which shows a life-cycle of an Information Technology.

A certification system for system engineers was introduced in 1969. It covers software

[9] It should be noted that Japanese word processors were not personal computers. Rather they were a kind of typewriter designed to input and print out the complex Japanese sentences ordinarily written by hand.

products and services for main-frame computers until 1980s. We can see the discontinuance of the curve indicating system engineers at 1994 in Fig 2, when the target of the national certification system was changed. The curve on the right hand side in Fig 2 shows, between 1988 and 1994, a fluctuation in the number of certified system engineers.

Fig 2 Number of system engineers (1969-1994), and system administrators and network technicians (1994-2000)



(compiled by the author from the on-line data published at Information-Technology Promotion Agency (IPA))
<http://www.jitec.jp/1_07toukei/excel/10_sanko1_sanko2_sanko3.xls>

The government changed certification in response to dramatic changes in information technology from stand-alone main-frame systems to network connected client–server systems and user-oriented systems in 1994. They have introduced the system administrator and network control technician certification.

It is evident that there is a similarity or correspondence between the curves in Fig 1, which shows the number of shipments, and the curves in Fig 2, which shows the number of certifications. Thus, we conclude that the state of the diffusion of certain technologies can be described by the number of shipments and also by the number of people who obtained their certifications of a technology.

5.2. Production function and Input-Output Model

Ronald E. Miller and Peter D. Blair state, "In input-output work, a fundamental assumption is that the interindustry flows from *i* to *j* – recall that these are for a given period, say a year – depend entirely on the total output of sector *j* for the same time period.[10]" They call a_{ij} a technical coefficient. When *j* industry doubles the volume of its product, it must consume double the amount of *i* product as intermediate consumption purchased from *i* industry. From this assumption, this type of production function, called Leontief production function, used in Input-Output Analysis requires "inputs in fixed proportion where a fixed amount of each input is required to produce one unit of output[11]." This fixed proportional input structure is called the technical structure of *j* industry. Although abrupt changes in the technical structure, or production function, are not supposed to be observed in a given short period, technological progress such as front-end ICT may change technical coefficients of some industries. If we observe the changes of the input coefficients of certain industries, it may be a trace of the diffusion of innovation.

To determine the quantitative degree of influence of the diffusion process of certain technology by using this Input-Output Model, we choose an appropriate industry where the production function would be changed by introducing emerging products. The life-cycle of products such as personal computers or smart phones etc. started thus in general. But, as we proposed above, we have chosen the number of people who obtained their certifications of a technology and the industries where these people worked.

More concretely, we have chosen the number of license holders of wireless technology in order to highlight the appropriate industries where front-end ICT allows the substitution of well-trained people by the advanced semi-automatic or fully automatic digital communication equipment.

We observe the change of technical coefficients in fishery, transport, telecommunication and broadcasting in this model, where wireless communication is essential and deemed by law.

6. Results

6.1. Number of communication operators or technicians

(1) Number of telephone exchange operators

Fig 3 shows the clear decrease in the number of telephone operators in five major industries in Japan: commerce, finance and insurance, communication, public administration and subtotal of other services. In 1970, the largest proportion of telephone operators was working in the telecommunication industry, but in 2000, other

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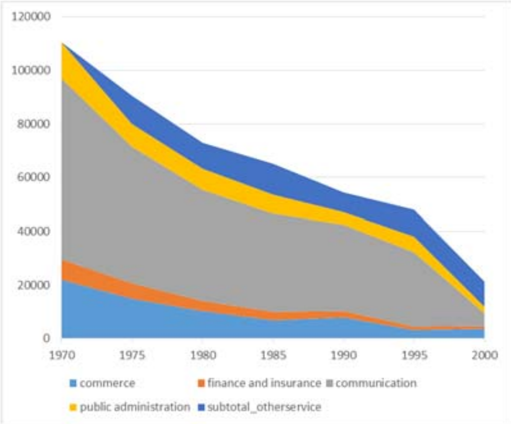
[10] Ronald E. Miller and Peter D. Blair (2009), Input-Output Analysis, P.15 l.7-5 from the bottom of the page. Cambridge University Press

[11] Id. P.19 l.7-9

service activities comprised the largest part. The total number was about 20,000 in 2000. About 90,000 operators quit their posts between 1970 and 2000.

Fig 3 Number of telephone operators in five major industries (1970-2000)

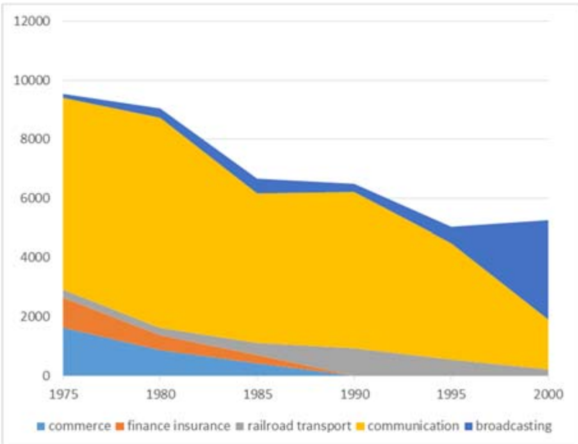


(compiled by the author from linked labor matrix; 1970-75-80, 1975-80-85, 1990-95-2000)

(2) Number of wired communication operators

As fig 4 shows, the number of wired communication operator decreased in all major industries except within rail-road transport in which the number of operators was increasing before 1990 but decreasing after this point. In commerce, and finance and insurance, wired communication operators had disappeared by 1990. This may have been the result of the disappearance of the telex system in these industries. In broadcasting, the number of wired communication operators slightly increased after 1990 and further expanded from 1995 to 2000. This may be the result of the introduction of new cabled broadcasting or cabled communication technologies.

Fig 4 Number of wired communication operators in major industries (1975-2000)



(compiled by the author from linked labor matrix; 1975-80-85, 1990-95-2000)

(3) Number of wireless communication operators or technicians

Wireless communication technology has been mainly used for mobile communication since its inception. Marconi's Wireless Telegraph Company Limited[12] established wireless telegraph communication over the Atlantic in1901, and this trial revolutionized mobile communications between ships and land, and ships and ships. Until then, a ship had no way to make off-shore communication. After the disaster of Titanic in 1912, the installation of a wireless telegraph station on board was made obligatory for most shipping in 1914. The occupation of wireless telegraphist on board became popular and was a dream for many of the younger generation. Mobile communication expanded to air communication and ground communication, such as railway and road transport after World War I. The utilization of electromagnetic wave expanded to television, RADAR, data gathering, remote control of machines, etc. In addition to the increasing use of electro-magnetic technology, after World War II, as a result of the demands of mass production and mass consumption, the technology was simplified so that many people were able to use it.

New technology was developed in higher radio frequencies and it was diffused in wireless communication in the late 1960s. The downsizing of wireless communication equipment started in the 1970s by introducing transistors. Semi-automatic or fully automatic radio communication systems with friendly and easy-to-use man-machine interfaces could be operated not only by skillful operators but also by radio technicians, as it was no longer necessary to hire well-trained radio operators.

We focused on ten major industries in which we observed employment of wireless operators or technicians. Their number was ranked in ascending order for the year 1990. The rank was listed by order; “printing, plate making and book binding”, “household electrical appliances”, “building construction”, “electricity”, “commerce”, “other industries”, “public administration”, “transport”, “fisheries”, “communication” and “broadcasting”.

Tab 1 shows the change in the number of wireless operators and technicians from 1970 to 2005. The total number of wireless operators and technicians in intermediate activities decreased from 39,116 in 1970 to 13,519 in 2005. We can see the three periods of this decline in Fig 5-a. They seem to correspond to the three different technology diffusion processes: first, usage of higher frequency technology, VHF or UHF, driven by

[12] This company changed its name in 1900 from its original name “Wireless Telegraph & Signal Company Limited” established in 1896.

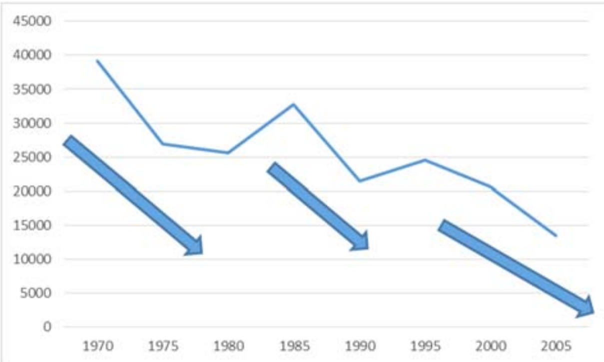
the use of transistors; second, satellite communication technology using SHF; third, digitalization and the front-end ICT revolution. The communication appliances became easy-to-use and semi- or fully automatic after 1995 through the use of advanced and sophisticated micro-processor units which replaced or built-in the knowledge and skill of former operators or technicians.

Table 1 Number of wireless operators and technicians in major 10 industries (1970-2005)

umber	1970	1975	1980	1985	1990	1995	2000	2005
Printing, plate making and book binding	338	521	78	195	87	0	0	0
Household electric appliances	1183	182	82	184	126	0	0	0
Building construction	310	110	104	107	235	0	0	0
electricity	238	149	161	181	366	653	245	230
Commerce	1167	415	286	521	507	0	0	0
other industries	1209	1032	1476	4058	1980	68	315	265
Public administration	3770	3257	3333	2971	2411	0	0	0
transport	10556	7185	7504	9250	3117	3444	1645	797
Fisheries	6206	4072	4630	3679	3205	3896	1182	850
Communication	6026	5943	3824	5414	4360	9876	3268	3364
broadcasting (other service (1970–75))	8113	3998	4087	6170	5087	6579	14017	8013
Total of intermediate industrial activities	39116	26864	25565	32730	21481	24516	20672	13519

(compiled by the author from linked labor matrix; 1970-75-80, 1975-80-85, 1990-95-2000, 1995-2000-2005)

Fig 5-a Total number of wireless operators and technicians in intermediate industrial activities (1970-2005)



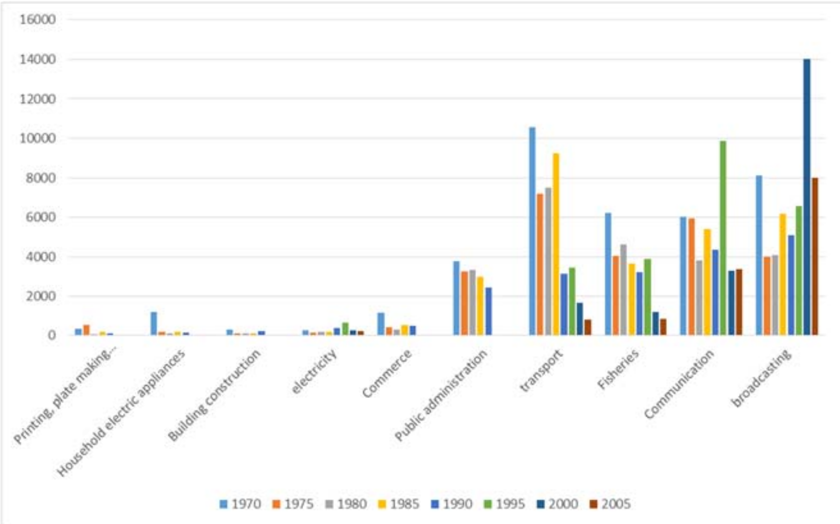
(compiled by author from linked labor matrix; 1970-75-80, 1975-80-85, 1990-95-2000, 1995-2000-2005)

In stark contrast to the decrease in the number of wireless operators and technicians in public administration, transport and fishery shown in Fig 5-b, we notice the opposite tendency within broadcasting. Well-trained and license-holding personnel in broadcasting has increased even recently.

In mobile wireless communication industries, such as fishery, transport and public service, the number of license-holding wireless operators were in decline since 1970 until

1990 and became almost extinct in 1995. Administration services provided meteorological information and accurate standard time signals to off-shore ships or to isolated lands. This type of radio diffusion commenced in the early twentieth century[13] and became extinct before the twenty-first century.

Fig 5-b Number of wireless operators and technicians in major industries (1970-2005)



(compiled by the author from linked labor matrix; 1970-75-80, 1975-80-85, 1990-95-2000, 1995-2000-2005)

6.2. Number of certified operators and technicians

(1) Number of radio operators and technicians licensees

To operate a wireless communication station, it is obligatory to obtain a radio operator or radio technician national license. Tab 2 and Fig 6, and also Fig 7 show the number of radio operators and radio technicians between 2003 and 2012.

The most popular license is the radioamateur's license. The number of license holders is more than 3.36 million but the rate of increase is low (0.3 % annual rate). It is believed that the diffusion of cellular phones has diminished interest in applying for the national radioamateur license examination in Japan. The second most popular license is for special ground radio technicians of numbering 1.75 million and expanding faster than any other radio license (11.9% annually). The number of holders of marine radio operator and special marine radio operator licensees is about 63,000 and 749,000 in 2012 respectively, and increasing at a modest annual rate of 0.5-0.6%. The number of holders

[13] « Le 23 mai 1910, la Tour inaugure le premier service régulier de diffusion de signaux horaire avec une puissance d'émission encore jamais atteinte dans le monde », Michel Amoudry (1993), Le Général Ferrié et la naissance des transmissions et de la radiodiffusion, p.19 l.23-25, Presses Universitaires de Grenoble

of air radio operator and special air radio technician licensees is about 50,000 and 75,000 in 2012 respectively and increasing at rather high annual rate of 1.4%. These annual rates of growth are not so small, if we take into account the fact that the Japanese population is decreasing.

In short, the population of radio operator licensees is expanding less than radio technicians. There is a shift from operators to technicians, but neither is in decline. Surprisingly, the number of special ground radio technicians is currently still expanding rapidly.

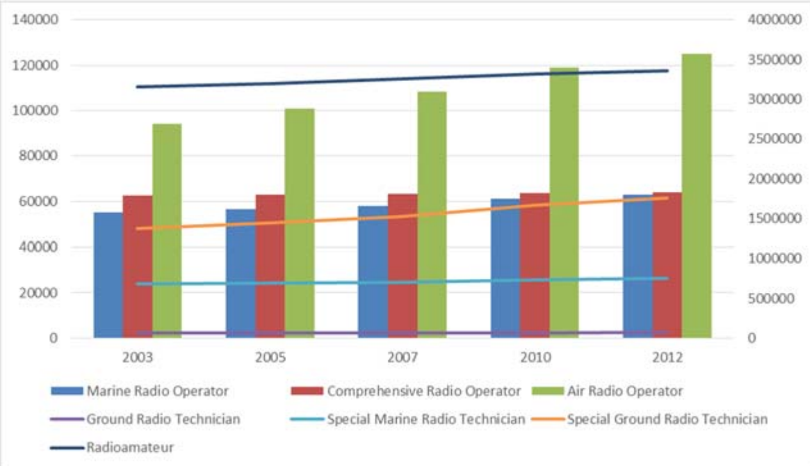
Table 2 Number of wireless licensees according to their license category (2003-2012)

	2003	2005	2007	2010	2012	average growth rate (%)
Marine Radio Operator	55241	56407	57915	61129	63031	0. 6
Comprehensive Radio Operator	62576	62859	63131	63562	63845	0. 1
Air Radio Operator	38044	40591	43272	47827	50238	1. 4
Ground Radio Technician	59104	61063	63114	67054	70140	0. 8
Special Marine Radio Technician	682320	693841	706290	731699	748933	0. 5
Special Air Radio Technician	56145	60470	64937	71066	74843	1. 4
Special Ground Radio Technician	1375516	1443990	1521681	1661681	1757779	1. 2
Radioamateur	3153789	3192744	3254491	3319709	3361904	0. 3

(compiled by the author from the data published at the web-site of Soumusyo; http://www.soumu.go.jp/johotsusintokei/field/denpa04.html)

Fig 6 shows the overview of these trends of radio operators or technicians. The red bar shows that the number of comprehensive radio operators remained stable. This comprehensive license is the highest license category at the international level.

Fig 6 Number of wireless licensees according to their license category (2003-2012)

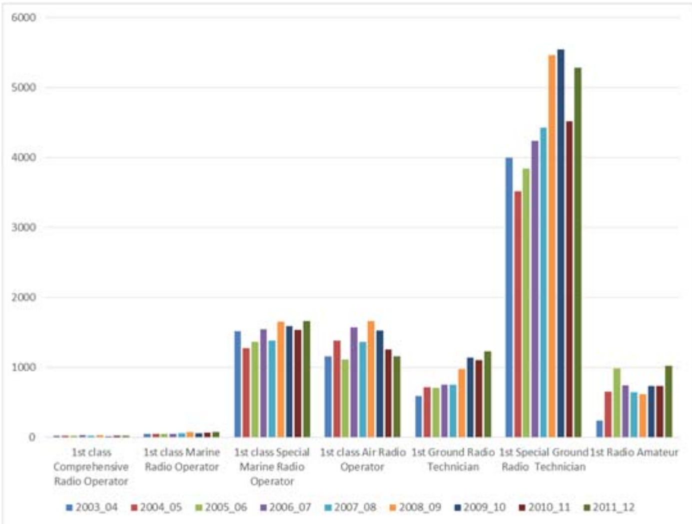


(compiled by the author from the data published at the web-site of Soumusyo;

http://www.soumu.go.jp/johotsusintokei/field/denpa04.html)

Fig 7 shows the recent annual differential number (an increasing number) of the national radio license holders according to their category. The speed of growth of the number of license holders is significantly higher among First Class Special Ground Radio Technicians and the First Class Ground Radio Technicians.

Fig 7 Annual differential number of Radio Operators or Technicians (2003-12)



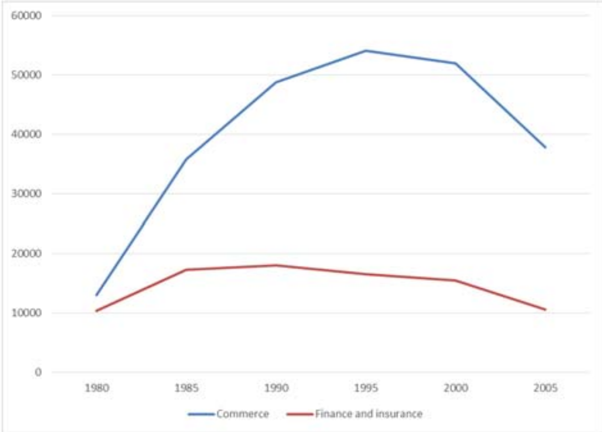
(compiled by the author from the same data as Fig 6)

(2) Number of system engineers and system administrators

Now, we are going to look at the number of system engineers in the IT field. Front-end IT development and its diffusion changed the man-machine interface in general. As a consequence, office machines and electronic typewriters were substituted by networked personal computers, connected to the back-end global network system. This is one typical example of out-sourcing of core office work such as keeping data secure. The back-end system, such as main-frame computers have disappeared from in-house offices.

The number of system engineers in commerce increased from 13,096 in 1980 to 54,141 in 1995, but started to decrease thereafter to 37,782 in 2005. The peak number of 18,002 in finance and insurance services was reached in 1990, as we can see in Fig 8-a. There seems to be a rapid evolution of Information Technology (IT) in general. This evolution has caused downsizing and the erosion of the bigger computers market such as the main-frames and mini-computers market. Most system engineers were trained for managing main-frames and subsequently have lost their jobs.

Fig 8-a Number of system engineers in commerce and finance (1980-2005)



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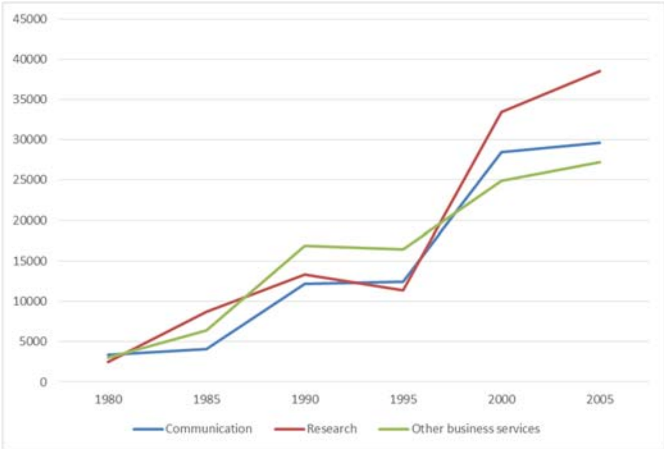
In contrast to Fig 8-a, there are no inverse U-curves in Fig 8-b. The curve is linear in this case. The number of system engineers, system administrators and network control technicians who were hired in communication, research, other business services and information services, increased steadily even after 1995. The number of system engineers in information service technologies is the highest. It rose from 48,137 in 1980 to 502,311 in 2005. The annual growth rate reaches 4.8% and 4.2% in research and information services respectively, as a result of work outsourcing from manufacturing or other service activities.

Table 3 Number of system engineers in major industries.

	1980	1985	1990	1995	2000	2005	annual rate of growth (%)
Communication	3390	4113	12187	12472	28460	29603	3.8
Research	2534	8675	13371	11407	33459	38485	4.8
Other business services	3023	6431	16901	16464	24867	27227	3.9
Information services	48137	161921	319162	255944	437107	502311	4.2
Total	129078	334562	547203	549179	698256	716089	3

(compiled by the author from the on-line data published at Information-Technology Promotion Agency (IPA))

Fig 8-b Number of system engineers in major industries.



(compiled by the author from the on-line data published at Information-Technology Promotion Agency (IPA))
http://www.jitec.jp/1_07toukei/excel/10_sanko1_sanko2_sanko3.xls

The qualification system for system engineers was changed by the central government in 1994 to adapt to market needs. Two categories have been added: system administrators and network control technicians who demonstrate user-oriented and network management ability.

Fig 2 shows the number of system engineers certified by the national qualification system, which was amended in 1994. The number of newly certified system engineers after this amendment reached 186,984 in 2000. The total number under the old qualification system was 486,420 from 1969 to 1994. However from 1994 to 2000 a period of only six years under amended system the number rose to 947,896. This abrupt change was successful because it helped the market move towards the downsizing, personalizing and networking.

As a result of the diffusion of new ICT in offices, the number of system engineers decreased in commerce and finance and the system engineers qualifications could not adapt to these market changes. In response to the new social needs, the government changed its qualification system and encouraged outsourcing service industries, such as information services, research services and other business services where the re-qualified system engineers and newly-trained system administrators and network managers started to work.

From these observed points, we can conclude that the diffusion of front-end ICT devalues highly-trained mono-competence operators or technicians, and opens higher professional opportunities to multi-competence operators or technicians to adapt the market change.

6.3 Technical structure changes of Input-Output Model

We have checked the number of wireless operators and technicians in major industries since the 1980s and found that new licensees of radio technologies could not find their posts in the major industries such as fishery, transport and communication. Only the broadcasting industry accepted them continuously. This caused a mutation in the occupational-employment structure.

Now we are going to check if the industrial structure changes in the Input-Output Model.

(1) Final demand vectors structure

We have chosen eleven industries where numerous wireless operators and technicians were working in Tab 1 but we have reduced the number of industries to four in order to clearly show the change of technical structure: fishery, transport, communication and broadcasting. Thus, we compiled the data to obtain Fig 9. The transport sector is divided into 4 sub-sectors: railway, road, water and air. In total, there are seven industries to analyze.

As shown in Fig 9, these industries are categorized into three types: (i) whether the output is declining or expanding, (ii) whether the trade activity is important or less important, (iii) intermediate output rather than final output.

Fig 10 shows the distribution of industries categorized by two (ii) trade activity and (iii) intermediate activity. Water transport and fishery are more open to the international market and depend on intermediate consumption. Air transport is also facing tough international competition but it mostly depends on final consumption. Railway transport also depends on final consumption and is less affected by international competition. Broadcasting, communication and road transport depend on intermediate consumption but are not affected by international competition.

Under the threat of international competition and less expansion of output, it is normal that industries such as water transport and fishery could not bear the heavier load. When international accords relaxed rules for on-ship wireless operators, they did not have any other choice.

The case of air transport is slightly different because of its dependency on final consumption. The administration could intervene to protect in the price policy in the consumer market.

Railroad transport is less under threat from international competition and it is possible to keep in-house skillful people. Road transport, communication and broadcasting do not depend on final consumption and have fewer trade opportunities with foreign countries. They have to negotiate with business partners to conclude their communication policy.

Fig 9 Final Demand Expenditure of major industries related to wireless communication activities (unit: million yen, current price) (1990-2005)

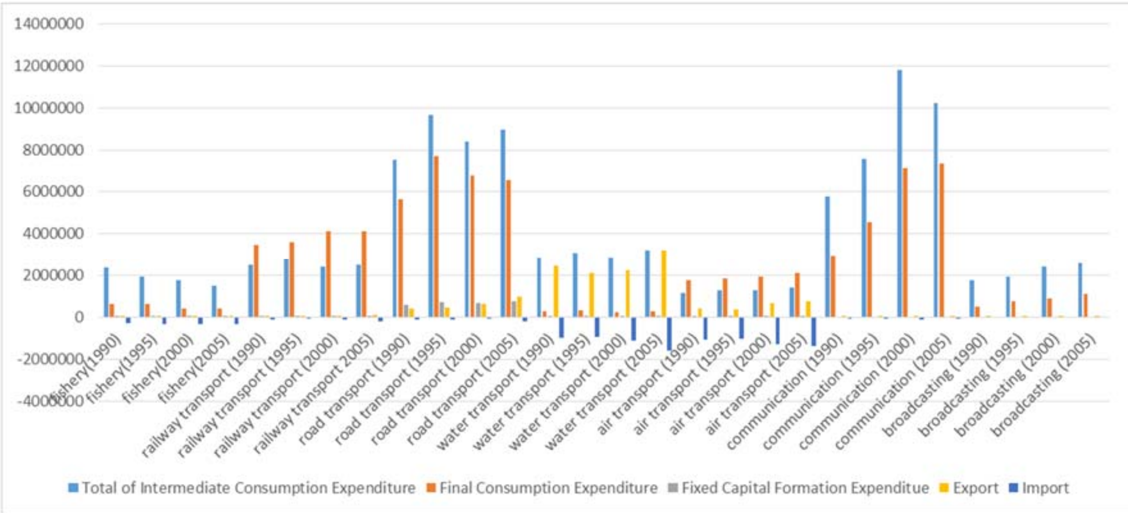
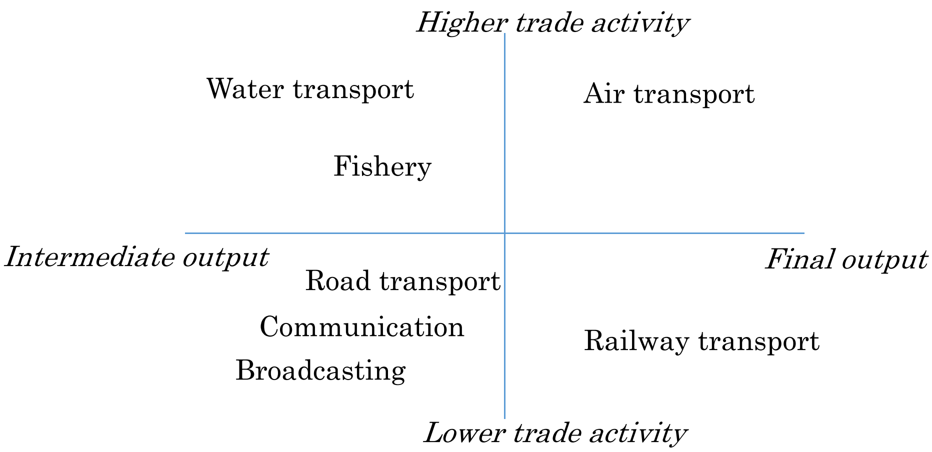


Fig 10 Characteristics of industries observed in Fig 9

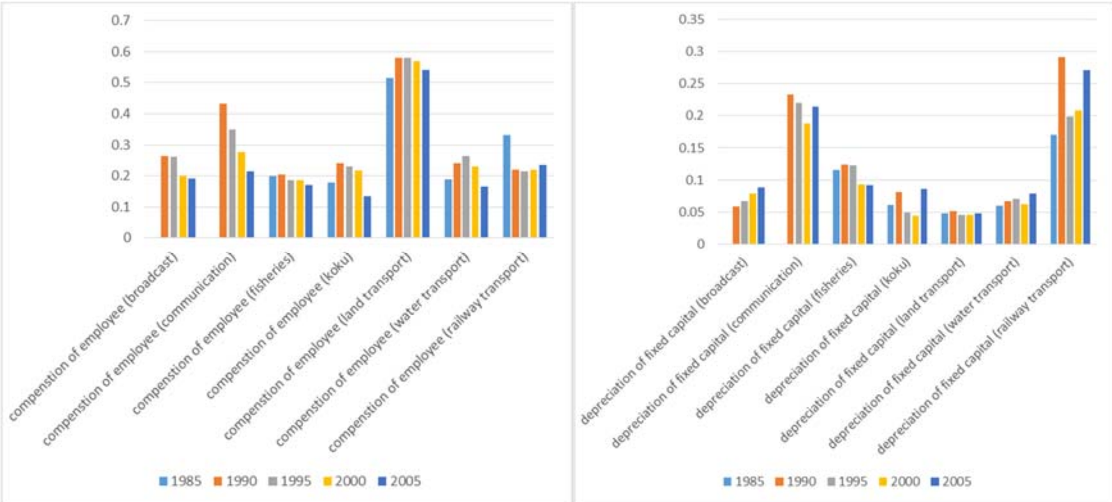


(2) Added-value structure

As shown in Fig11-a which indicates the input coefficients of wages and salaries (compensation of employees), the coefficients were declining continuously in broadcasting, communication and fishery. The trends in air (koku), land and water transport indicate like an inverse U. These coefficients reflect the labor cost in general. Fig 11-b shows the input coefficients of depreciation of fixed capital. The coefficients of depreciation of fixed capital is related to the capital cost. These coeefficients increase in broadcast and water transport but decreased in communication and fisheries.

The changes of coefficients of each industry could be classified by two axes: labor cost and capital cost with which axes we can draw Tab 3.

Fig 11-a Input coefficients of wages and salaries (compensation of employees) and Fig 11-b Input coefficients of depreciation of fixed capital (1985-2005)



Tab 3 Classification of the coefficients changes of observed industries (1985-2005)

	broadcast	Communi cation	fisheries	air transport	land transport	water transport	railway transport
labor cost	↓	↓	↓	inv.U	inv.U	inv.U	→
capital cost	↑	U	↓	→	→	↑	↑

(3) Input coefficients structure or technical structure

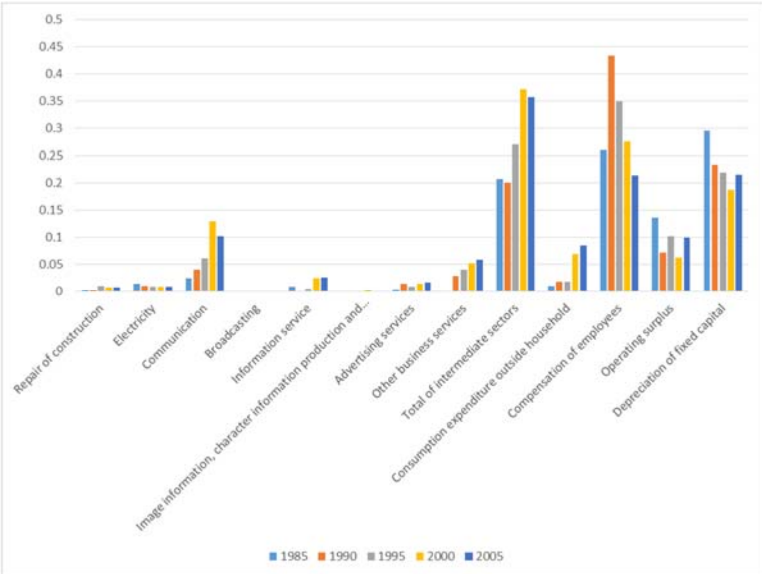
(This part will be completed later and presented at the IIOA conference)

(a) Communication industry

It is obvious that the communication industry changed its input coefficients between 1985 and 2005. This industry was privatized in 1985. The total intermediate consumption coefficient increased significantly from 0.20 to over 0.35 and, in contrast to this, the coefficient for compensation of employees (wages and salaries, expenditure on labor cost) and depreciation of fixed capital were reduced by half from 0.43 to 0.21 and by a quarter from 0.3 to 0.2 respectively. The reduction of the coefficient of depreciation of fixed capital is important because it is related to former investments.

The most important change from 1985 to 2005 was that observed at communication and at other business services. They were increased constantly. This means inter-industrial relations were strengthened by outsourcing of core competence services in communication. The reduction of compensation of employees started after 1990. It was 0.44 in 1990 and fell to 0.21 in 2005. The labor cost was reduced by a half. Corporate consumption increased from 0.01 to 0.08, an eight-fold increase.

Fig 12 Input coefficients of communication industry (1990-2005)



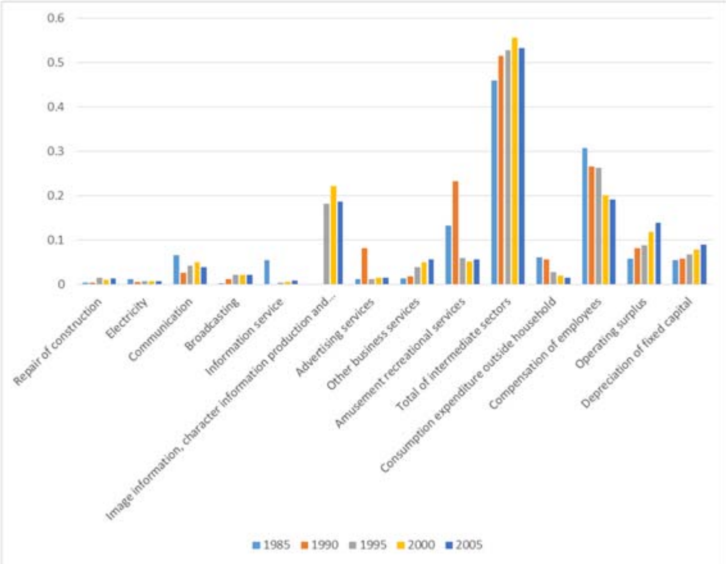
(compiled by the author from linked IO tables of 1990-1995-2000 and 1995-2000-2005 of MIAC)

(b) Broadcasting

(This part will be completed later and presented at the IIOA conference)

In the broadcasting industry, we can see the reduction of the intermediate consumption coefficient but it was as marked as in communication. The coefficient of compensation of employees was reduced from 0.30 in 1985 to 0.19 in 2005 in contrast to the increase of operation surplus from 0.06 to 0.13. The coefficient of depreciation of fixed capital was also increased steadily from 1985 to 2005.

Fig 13 Input coefficients of the broadcasting industry (1990-2005)



(compiled by the author from linked IO tables of 1990-1995-2000 and 1995-2000-2005 of MIAC)

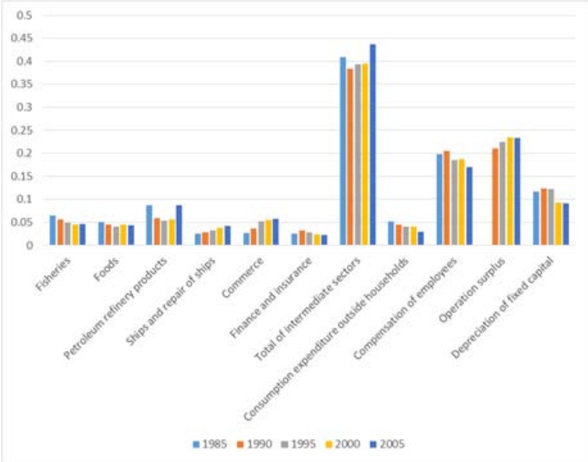
There is a relevant change of value added vector in broadcasting. The coefficient of the payment of salary decreased slightly from 0.26 to 0.19 in contrast to the expansion of capital depreciation costs from 0.06 to 0.09 and business surplus from 0.8 to 0.14.

The outsourcing of communication services from 0.02 to 0.04 is also observed and this pushes up the coefficient of total intermediate consumption from 0.51 to 0.53. The input to the amusement service in 1990 was shifted to the input to the contents service of which category was added in 1995. This is a technical shift and there is no clear change of outsourcing policy of contents in broadcasting activities.

(c) Fishery

(This part will be completed later and presented at the IIOA conference)

Fig 14 Input coefficients of fishery (1985-2005)



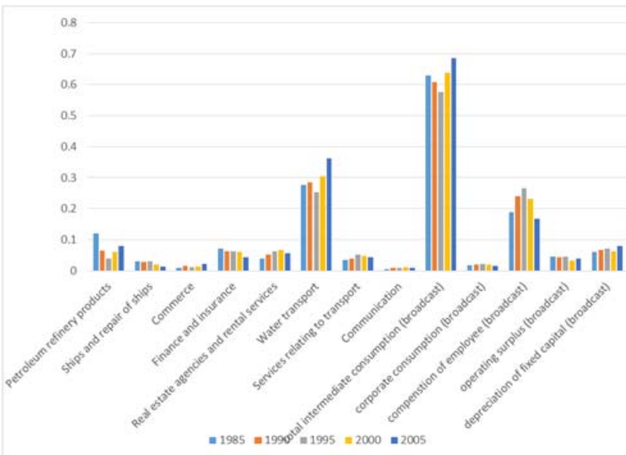
(compiled by the author from linked IO tables of 1990-1995-2000 and 1995-2000-2005 of MIAC)

(d) Water transport

(This part will be completed later and presented at the IIOA conference)

Expenditure on labor costs increased until 1995 and then decreased thereafter until 2005. It seems that this expenditure increase in labor costs was compensated for the reduction of intermediate consumption, such as the reduction of inter-professional expenditure, in other words, reducing core out-sourcing expenditure.

Fig 15 Input coefficients of water transport (1985-2005)



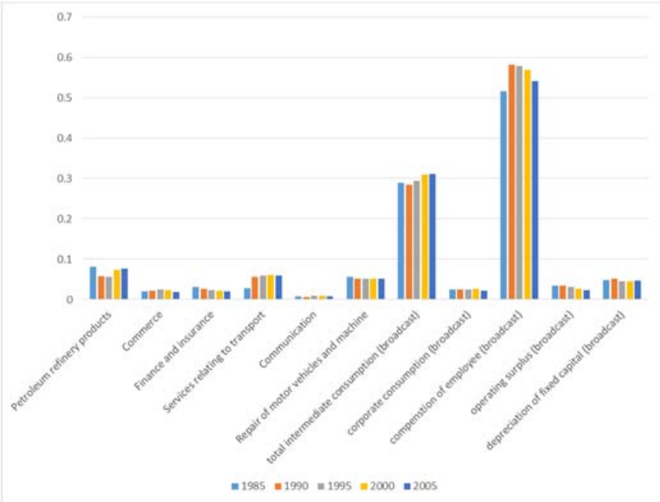
(compiled by the author from linked IO tables of 1990-1995-2000 and 1995-2000-2005 of MIAC)

(e) Road transport

(This part will be completed later and presented at the IIOA conference)

It seems that fuel cost expenditure, of which input coefficients reach between 0.5 and 0.6, is directly related to the compensation for employees. This means labor cost covers 50 or 60% of the total costs in the road transport service. There is no room for out-sourcing.

Fig 16 Input coefficients of road transport (1985-2005)

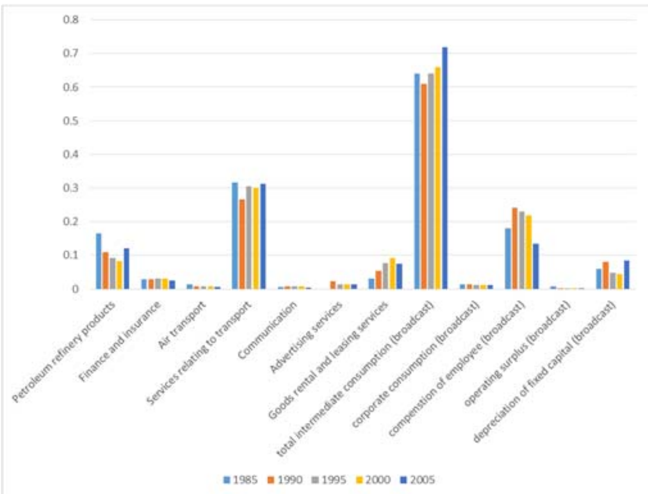


(compiled by the author from linked IO tables of 1990-1995-2000 and 1995-2000-2005 of MIAC)

(f) Air transport

(This part will be completed later and presented at the IIOA conference)

Fig 17 Input coefficients of Air transport (1985-2005)



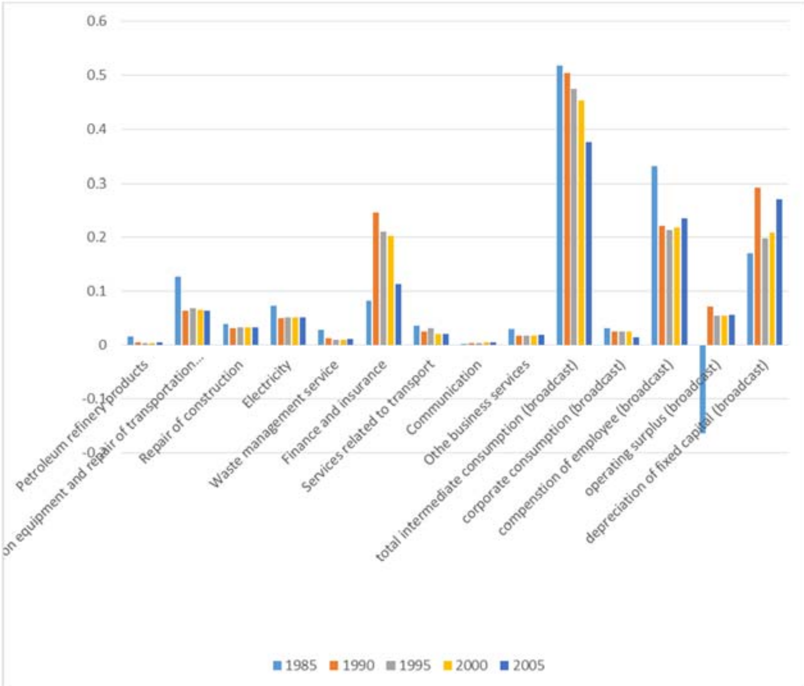
(compiled by the author from linked IO tables of 1990-1995-2000 and 1995-2000-2005 of MIAC)

(g) Railroad transport

(This part will be completed later and presented at the IIOA conference)

The transport service industry in Japan was privatized in 1987. As a consequence, there is some discontinuance of input coefficients between 1985 and 1990, because the debt was restructured by force of the government to restart the privatized transport service companies.

Fig 17 Input coefficients of railroad transport (1985-2005)

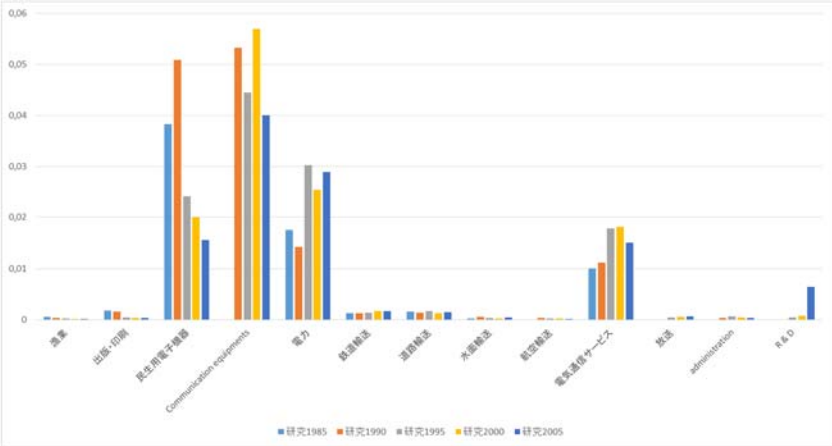


(compiled by the author from linked IO tables of 1990-1995-2000 and 1995-2000-2005 of MIAC)

(h) Research and development (Output coefficients)

(This part will be completed later and presented at the IIOA conference)

Fig 18 Output coefficients of research and development (1985-2005)

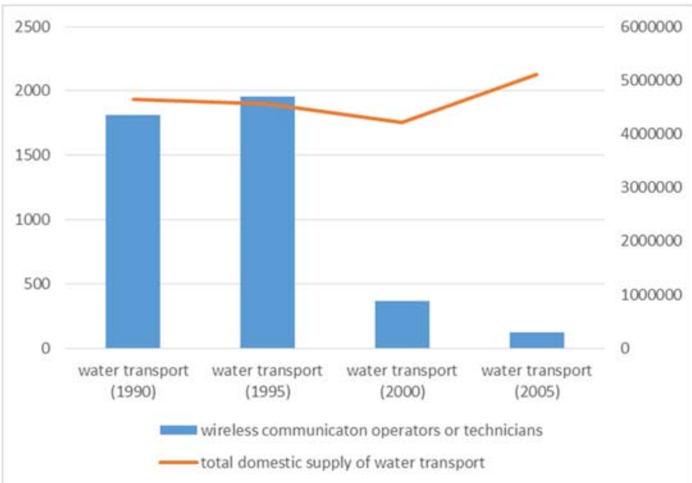


(compiled by the author from linked IO tables of 1990-1995-2000 and 1995-2000-2005 of MIAC)

(i) Consequence of the decrease of the number of wireless operators in certain industry
(This part will be completed later and presented at the IIOA conference)

Fig 19 shows a typical result of total output of an industry where many well-trained wireless operators have lost their professional post. There is no dumping curve of the output.

Fig 19 Relationship between the number of wireless operators and total output of water transport (1990-2005)



7. Conclusions
(This part will be completed later and presented at the IIOA conference)

In conclusion, steady decreasing of the number of telephone operators and wired communication operators reflected the evolution of manually-operated telephone system to dial-up automatic system since 1970, but, there was different tendency in wired communication operators in broadcasting after 1995. This corresponds to the introduction of new cabled broadcasting or communication technology in broadcasting services which needed newly well-qualified operators.

Our results show also a drastic industry-occupation structure change in several production activities, such as (1) an institutional decrease in the number of telegraphists water and land transport activities in the 1980s, despite the increase in the number of wireless operators and technicians, (2) the inverse U-curve change in the number of system engineers (SEs) employed in commerce, and finance and insurance activities in the last quarter of twentieth century, despite the steady increase in the number of the SEs in information service or research activities, (3) the rise of the number of special ground radio technicians, system-administrators and network control technicians who work not only in communication or information service but also in any service activities.

This shows that the diffusion of front-end ICT devalues highly-trained mono-competence operators such as telephone operators or technicians, and opens higher professional opportunities to multi-competence operators or technicians such as wired communication operators and network-oriented system engineers. The labor-cost in industrial structure also decreased in almost all ICT related industries.

(end of article)

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