comprises several steps like below,

(1) Estimate number of workers of software professionals.
  (1)-1 Exclude workers linked to custom software and reproduction software to be sold.
  (1)-2 Exclude working time linked to other activities.
(2) Estimate wages for software professionals and compute labor cost.
(3) Estimate non-labor costs for own-account software.

Step-(1) is to estimate number of workers of software professionals. Since it is difficult to directly observe the number of software professionals, employment data by occupation can be used. On the International Standard Classification of Occupation in 1988 (ISCO 88), occupations related to software professionals are 213.Computing professionals and 312.Computer associate professionals. ISCO-213 consists of 2131.Computer systems designers, analysts and programmers and 2139.Computing professionals not elsewhere classified. ISCO-312 consists of 3121.Computer assistants, 3122.Computer equipment operators, and 3123.Industrial robot controllers. The OECD Task Force recommends the coverage of employees should be limited to the number of computing professionals (ISCO-213) for international comparability (recommendation 5(8)).

In Japan, occupation classification in the Population Census is based on the Japan Standard Classification of Occupation (JSCO). Table 1 shows the rough occupational concordance between ISCO and JSCO. As we compare the shares of ISCO-213 and JSCO-06 in section 3, they are almost consistent.

In the U.S., the Bureau of Labor Statistics (BLS) uses Standard Occupational Classification (SOC). The group of the three occupational categories, SOC-15-1020.Computer programmers, SOC-15-1030.Computer software engineers, and SOC-15-1050.Computer System Analysts, are almost consistent with ISCO-213. In this paper, we label the occupation of the workers engaged in own-account software production simply as "software professionals" or ISCO-213.

Table. 1 Concordance between ISCO and JSCO on Software Professionals

ISCO 1988	JSCO 1997
213.Computing professionals	06.Computing professionals
2131.Computer systems designers, analysts and programmers	061.system engineers
2139.Computing professionals not elsewhere classified	062.programmers
312.Computer associate professionals	31.Office machinery operators
3121.Computer assistants	311.stenographers, typists, and word processor operators
3122.Computer equipment operators	312.Key punchers
3123.Industrial robot controllers	313.Computer operators
	319.Other office machinery operators

ISCO: International Standard Classification of Occupation

JSCO: Japan Standard Classification of Occupation

At step-(1), we need two adjustment processes. At first as (1)-1, we have to exclude workers linked

to custom software and reproduction software to be sold. Software professionals we observe work in production processes of originals and reproduction of originals. The BEA limits the maximum shares of employment in three digit-SIC-level industries to a maximum of 0.2 percent of total employment in each industry (Grimm-Moulton-Wasshausen[2003]). Numbers in excess of these limits are assumed to be engaged in the production of custom software and reproduction software to be sold.

The second adjustment at step-(1) is a limitation of working time. The BEA assumes that 50 percent of working time of software professionals is spent doing tasks associated with new investment rather than such activities as minor revisions and upgrades and maintenance (Paker-Grimm[2000] and Grimm-Moulton-Wasshausen[2003]). This 50 percent deduction rule originates from a study on the share of software development and maintenance costs in 487 business organizations reported by Barry Boehm[1981][*6]. The OECD Task Force recommends the 50 percent deduction rule can be applied as an upper limit (recommendation 5(11)).

Step-(2) is the estimation of wages for software professionals and labor costs of own-account software production. The OECD Task Force recommends that labor costs should be based on compensation, including net salaries and wages, but also social contributions (employer and employee, including imputed contributions).

At last, step-(3) is to estimate non-labor costs. Non-labor costs comprises intermediate consumption, consumption of capital, operating surplus, etc. The OECD Task Force recommends the use of the relationship between labor cost and non-labor costs derived from computer industries (if possible, custom software developments would be preferable) (recommendation 5(12)).

3 Measurement of Own-Account Software Investment

3.1 Number of Software Professionals

In order to estimate own-account software investment in Japan in terms of the methodology in section 2.2, we start with the estimation for the number of software professionals (ISCO-213).

Table 2 represents the share of software professionals, which is defined by JSCO-06, to total workers in Japan. The right three columns on the table are limited to employee and the left three columns are based on employment, which is defined by the total of employee, self-employed, and unpaid family workers. The data for Japan is based on the Population Census in each benchmark year. Although the Population Census has been conducted almost every five years since 1920, the occupation classification for the JSCO-06 has been separated only since the 1970 survey. Here, we examine the data in 1970, 75, 80, 85, 90, 95, and 2000.

In 1970, the share of employees engaged as software professionals to total employees is 0.13 percent; 0.18 percent for male and 0.04 percent for female[*7]. The share gradually increases and reaches to 1.13 percent in 1990. In the 1990s, the Japanese economy was in a long depression, which was the so-called

[*6] Although the best point estimate of the share of time spent on investment is 62 percent in Boehm's report, the BEA uses a 50 percent share to emphasize the approximate nature of the estimate (Parker-Grimm[2000]). Lequiller-Ahmad-Varjonen-Cave-Ahn[2003] reports Canada, France, and Italy also use this 50 percent deduction rule.

[*7] In the 1970 Population Census, the data in Okinawa prefecture, which was restored to Japan in 1972, is excluded.

Table. 2 Share of Software Professionals to Total Workers in Japan

	Employment			Employee		
	Total	Male	Female	Total	Male	Female
1970	0.09	0.13	0.02	0.13	0.18	0.04
1975	0.15	0.22	0.04	0.22	0.29	0.06
1980	0.23	0.34	0.05	0.32	0.44	0.08
1985	0.55	0.77	0.20	0.72	0.96	0.29
1990	0.91	1.26	0.37	1.13	1.52	0.48
1995	0.94	1.35	0.32	1.13	1.59	0.40
2000	1.23	1.80	0.41	1.43	2.07	0.49

unit: percent. Software Professionals is defined by the JSCO-06 in Table 1.

"lost decade". Since households have confronted the decreases of household income during the lost decade, many females, who had not worked or worked as unpaid-family workers, were compelled to enter labor markets to compensate for the decrease of total household income. During 1990-95, the growth rate of total female employees is 2.0 percent, which is twice as fast as the growth rate of male employees. In the same period, female software professionals decreases annually by 1.8 percent, although males increase by 2.0 percent. So the share of software professionals increases for males and decreases for females. This contrastive movement may be related to the difference of labor quality between males and females. In 1995, the wage rate for female system engineers is 20.0 percent lower than that for males, based on the Basic Survey on Wage Structure published by MHLW (Ministry of Health, Labour and Welfare, Japan) as described in section 3.3.3. In this paper, we apply different wages for males and females to measure own-account software in section 3.3.

During 1995-2000, the expansion of software professionals is outstanding. The growth rates of employees of software professionals are 4.8 percent for males and 4.6 percent for females. In the same period, total male employees decrease by 0.4 percent and females increase by 0.8 percent, annually. The share of software professionals increases to 1.43 percent in 2000.

The international comparison of shares of software professionals to total employees is in Table 3. Here, the U.S. share is computed by the Occupational Employment and Wages (BLS), 2000. The data in the other OECD countries but the U.S. and Japan is excerpted from Ahmad[2003].

From the view of point of international comparison of software professionals, we should note the differences in the definition of occupational classification among countries. Ahmad[2003] points out that the employees in ISCO-213 in the United Kingdom is overestimated because no employees are recorded within ISCO-312. As described in section 2.2, the Population Census in Japan uses JSCO. Here, we substitute JSCO-05 for software professionals (ISCO-213) and JSCO-31 for software associated professionals (ISCO-312). In Japan, the share of ISCO-213 to the total of ISCO-213 and ISCO-312 is 67.4 percent. This value is less than that in Sweden-1999 and almost similar to the share in France-1998. We can conclude there is no significant difference between the occupational definition for software professionals in Japan and that in other OECD counties.

Keeping the inconsistency on the U.K. in mind, the share of software professionals in Japan is the

Table. 3 International Comparison of Software Professionals

	Year	a.Share	b.ISCO-213	c.ISCO-312	d.b/(b+c)
Italy	1998	0.0	13196	13868	48.8
Greece	1998	0.2	7444	7196	50.8
Spain	1996	0.3	44026	34107	56.3
Denmark	1997	0.4			
France	1998	0.4	196705	99011	66.5
Australia	1998/99	0.7			
Finland	1995	0.8	18967		
Netherlands	1998	0.9	100765	82144	55.1
Canada	1998	1.0			
United States	2000	1.3	1633280		
Sweden	1999	1.3	75881	24474	75.6
Japan	2000	1.4	753493	363753	67.4
(United Kingdom)*)	1999	1.8	473915	0	100.0

a.Share is ISCO-213 to total employees (unit:percent). Countries sorted by the share.

b. and c. is number of employees. d. is share of ISCO-213 (unit:percent).

U.S. is by Occupational Employment and Wages (BLS), 2000. (SOC-26-1020,30,50 for ISIC-213)

Japan is by Population Census (MIC), 2000. (JSIC-06 for ISIC-213)

Countries but the U.S. and Japan are from Ahmad[2003].

*)UK's number probably includes the number of workers on ISCO-312.

highest level in the world, reflecting the difference of industrial structures among countries. The number of employees as software professionals is 753 thousand in Japan, which is the second biggest in scale.

Figure 2 represents The Japanese industrial distribution of employee and employment of software professionals in 2000.[8] In the Population Census, the industry classification is defined based on the establishment, to which workers belong. So, industry categories might give some information to identify the sorts of produced software, in which software professionals are engaged.

In 2000, 60.3 percent of software professionals work in software industry. Also, 6.9 percent belong to the information service industry. In the above two industries, the software professionals (67.2 percent) are engaged in the production of software originals and reproduction of the originals. Software professionals in industries except information services and software (32.8 percent) are unlikely to be engaged in custom software production. Software professionals in government can be interpreted to be engaged only in own-account software, by definition.

The share of software professionals in software and information service industries has a clear upward trend. In comparison with 67.2 percent in 2000, in 1995 software professionals in the two industries

[8] Here, we aggregate the original 217 industries in Population Census to 46 Industries and not elsewhere classified. The total number of employee by industry is the same as the number in Table 3. We can neglect the consistency problem between own-account and mineral exploration, which is capitalized as one of intangible assets in the Japanese official national accounts based on SNA93 recommendation, since software professionals in mining industry are very small in Japan.

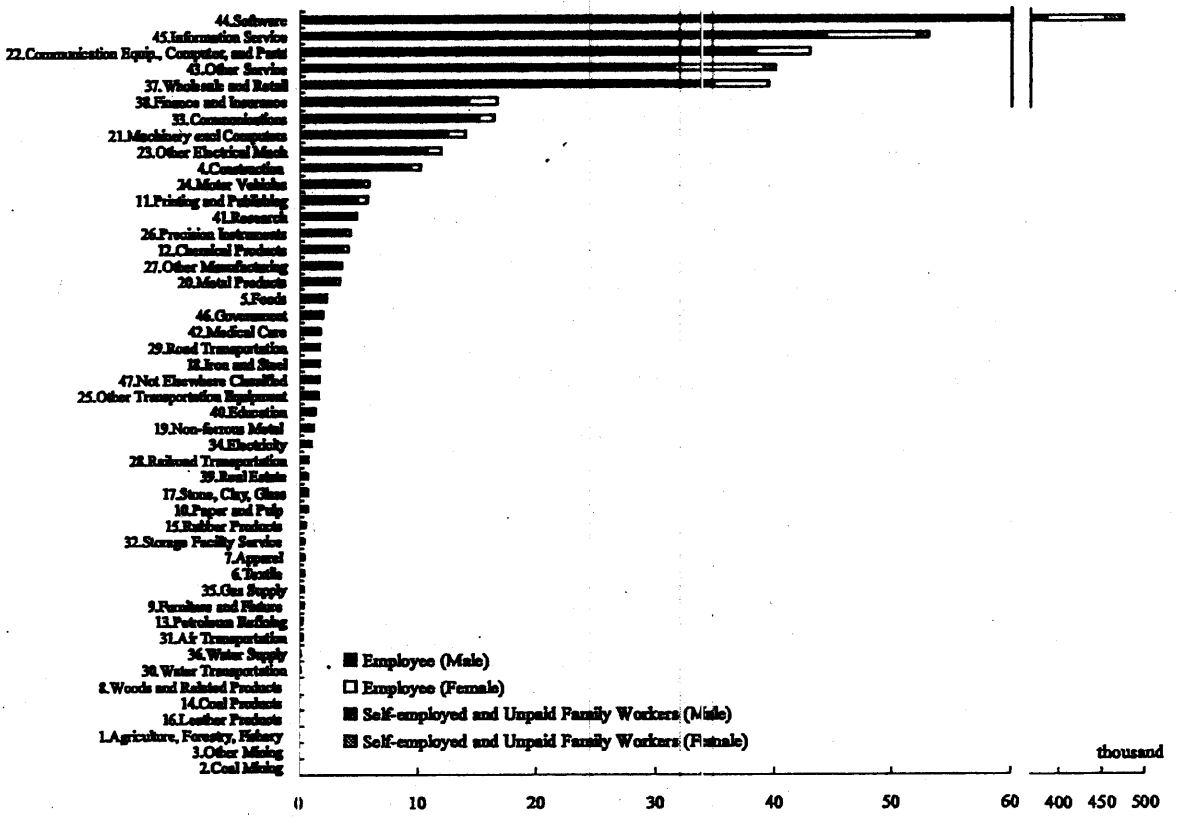


Figure. 2 Software Professionals by Industry in 2000

make up 62.0 percent in 1995, 58.9 percent in 1990, 35.6 percent in 1980, and less than 20 percent in 1970.[*9] This trend should be taken into consideration in estimating the number of software professionals.

3.2 Aggregate Estimates Based on the OECD Task Force Methodology

As the first approach in this paper, we estimate own-account software investment using the internationally harmonized methodology proposed by the OECD Task Force at the aggregated level. Ahmad[2003] derives the harmonized estimates of own-account software investment for several OECD countries except Japan.

Ahmad's harmonized estimation at the aggregate level is based on two basic assumptions. The first assumption is that 50 percent of the labor cost for software professionals is spent doing tasks associated with new investment of own-account software. In other words, the 50 percent deduction rule has two roles: to exclude workers linked to custom software and reproduction software to be sold and to exclude working time linked to other activities. The second assumption is that the ratio of non-labor costs over

[*9] In the Japanese Population Census, the exact comparison for software and information service industries is difficult, since the industry classifications are not fully disaggregated before 1990. Here, the shares for the benchmark years (except 1995 and 2000) are the maximum estimates. We can extract the clear upward trend, nevertheless.

labor cost is fixed at 1.017, which is the ratio in 1992 in the U.S.

Table. 4 Own-Account Software Investment by Harmonized Methodology of the OECD Task Force

					Own-Account Software Investment				
	Year	ISCO-213	Wage	LC	Harmonized Estimates			Official	
Australia	1998/99	76976	34273	1319	2661	(4200)	[0.7]	(2831)	[0.5]
Canada	1998	201700	29876	3013	6077	(8937)	[1.0]	(3372)	[0.4]
Sweden	1999	75881	40631	1542	3109	(25472)	[1.3]	(10449)	[0.5]
U.S.	1992	1175000	48000	27962	56400	(56400)	[0.9]	(34600)	[0.6]
	2000	1633280	64785	52906	106712	(106712)	[1.09]	(72100)	[0.73]
Japan	1980	128967	16862	1087	2193	(497)	[0.21]	n.a.	
	1985	317423	18052	2865	5779	(1378)	[0.42]	n.a.	
	1990	551650	32680	9013	18180	(2633)	[0.59]	n.a.	
	1995	593019	56952	16887	34061	(3204)	[0.64]	n.a.	
	2000	753493	55194	20794	33008	(4520)	[0.87]	n.a.	

ISCO-213 shows the number of total software professionals. Wage shows average annual wage evaluated in the U.S. dollor. LC (Laor Cost) and harmonized estimates are defined by million dollar and estimates evaluated by national currency are in ( ). The percentage of estimates over nominal GDP in [ ]. Official shows the values in the published national accounts by national currency in ( ).
Australia, Canada, Sweden, and the U.S.(1992) are the harmonized estimates by Ahmad[2003].

Based on the two basic assumptions, we estimate own-account software in 2000 in the U.S., and in benchmark years in Japan. Table 4 shows the harmonized estimates if the OECD Task Force recommendations are applied. The Japanese own-account software is 4.52 trillion yen in 2000. This value is 39.3 percent of that in the U.S. In the total number of software professionals, the number in Japan is 46.1 percent of that in the U.S. Because of the wage gap between the U.S. and Japan, however, the gap of own-account software investment expands in nominal value.

The share of own-account software over official GDP in 2000 in Japan is 0.87 percent.*[10] In table 4, we excerpt the harmonized estimates for Australia(1998/99), Canada(1998), Sweden (1999), and the U.S.(1992) from Ahmad[2003]. In comparison with other countries, the share of own-account software investment in Japan is a little smaller than that in Canada.

Ahmad[2003] discusses that the harmonized estimates are significantly higher than the official value of own-account software in each country. In Canada (1998) and Sweden (1999), the official investment in their national accounts is less than half of the harmonized estimates. In the U.S., the official investment of own-account software investment is 38.7 percent lower than the OECD-harmonized estimates in 1992. Also in 2000, the BEA's estimate is 32.4 percent lower than the harmonized estimate. This may be why the harmonized methodology abandons the industry category in order to reconcile differences of data availability among countries.

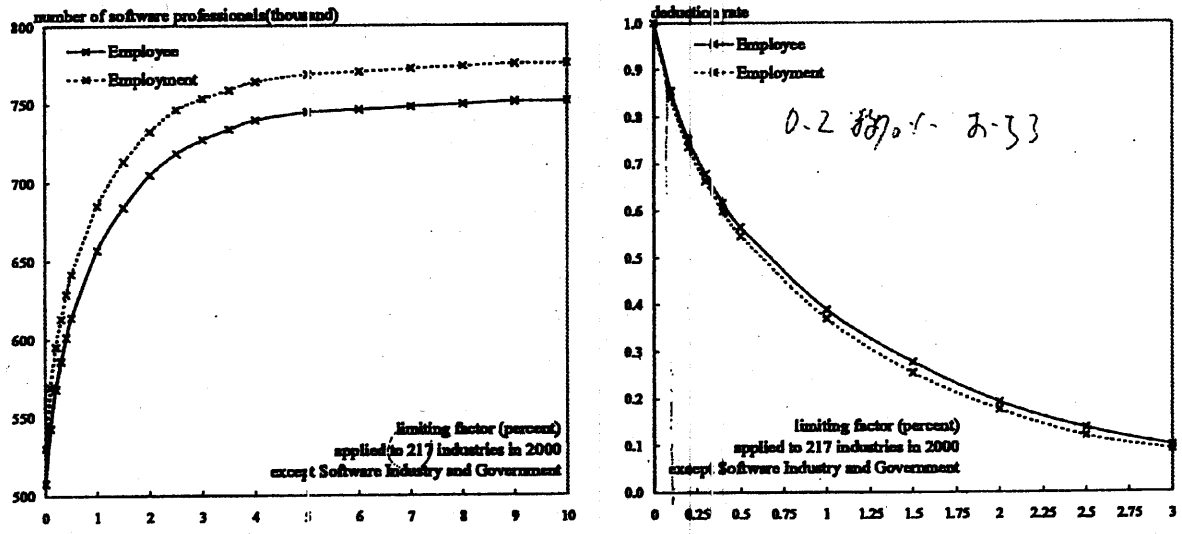
*[10] Here, we define GDP as official GDP + own-account software investment (our estimates) + prepackaged software investment (our estimates), since Japanese official GDP excludes these categories.

3.3 Measurement by Industry

3.3.1 Software Professionals in Non-Software Industries

The harmonized methodology in the previous section does not use the information of industrial distribution of software professionals. Next, as the second approach in this paper, we examine the application of the BEA's methodology.

The workers defined as software professionals in Table 3 are engaged in the production not only of own-account software, but also of custom and reproduction software to be sold. As described in section 2.2, we should exclude workers linked to custom and reproduction software to be sold. Here, we split this adjustment process into two procedures. The first procedure is the adjustment for non-software industries and the second is the adjustment for software industry.



(a) Number of Software Professionals

(b) Deduction Rate

Figure. 3 Limiting Factor for Non-Software Industry and Number of Software Professionals

Figure 3 shows the impact on the adjusted number of own-account software professionals and the deduction rate, applying limiting factors to every non-software industry. The BEA sets 0.2 percent of total employment as a maximum share of employment of software professionals in each three digit-SIC-level industry (Grimm-Moulton-Wasshausen[2003]). Here, we examine limiting factors to 217 industries in 2000 in Japan. The exceptional industries are the software industry, for which the 0.2 percent limiting factor is too restrictive, and government, which has no employment of software professionals engaged in the production of custom and reproduction software to be sold, by definition[11]. The scale of the horizontal axis of Figure 3(a) indicates limiting factors defined by percentages. The vertical axis indicates

[11] Here, the software industry is defined as "computer programming and other software services" and "data processing and research information services". In the Population Census 2000, the share of software professionals to total employees