the total number of software professionals adjusted by limiting factors in each industry. If the limiting factor is zero, software professionals in all non-software industries are assumed to be engaged only in the production of own-account software. The intercept on the vertical axis means the number of software professionals in software industry and government.

If we apply the BEA's 0.2 percent rule for each non-software industry, 183.5 thousand software professionals should be deducted in total. The total deduction rate is 75.4 percent in non-software industries, as shown in Figure 3(b). Table 5 represents the adjusted numbers and the deduction rates of software professionals by industry in 2000, when the limiting factors are 0.1 percent, 0.2 percent, 1.0 percent, and 2.0 percent. In the case of applying the 0.2 percent limiting factor, 96.1 percent of software professionals in the communication industry are deducted. Also, for manufacture of communication equipment, computer, and peripheral equipment, 93.6 percent are deducted. The deduction rates for the two industries, which represent IT users and IT producers, respectively, seems too large.

In all of the non-software industries, the share of software professionals to total employee is 0.5 percent (0.7 percent for males and 0.1 percent for females) in 2000. The 0.2 percent rule used by the BEA seems too restrictive to apply to the Japanese occupational structure by industry. In the case of the 2.0 percent limiting factor, 46.9 thousand employees are deducted and the deduction rate is 19.3 percent in total. The deduction rate in communication industry is 68.4 percent and that in manufacture of communication equipment, computer, and peripheral equipment is 48.3 percent, as described in Table 5. Even in this case, the impact to some IT-related industries may be too large.

Examining the make-table, which describes product-mix by industry, non-software industries produce only 2.5 percent of the total output of software and information services in 2000.[*12] Software professionals in non-software industries are unlikely to be engaged in custom software production. Prepackaged software produced by non-software industries may be included in this 2.5 percent at the make-table. Although software professionals for the reproduction of prepackaged software must be excluded here, the production cost of originals for prepackaged software should be capitalized as own-account software. Here, we assume that the cost for reproductions is negligible and that all software professionals linked to prepackaged software are engaged in the production of the originals to be reproduced. In this paper, we account all software professionals in non-software industries to be engaged in the production of own-account software, as originals to be reproduced or to be used in other production.

3.3.2 Software Professionals in Software Industry

The second procedure is the adjustment of the number of workers in the software industry. Software professionals in the software industry are engaged in the production of own-account software, custom software, and prepackaged software. For the adjustment of reproduction of prepackaged software, we assume all software professionals linked to prepackaged software are engaged in the production of the

is 68.4 percent in computer programming and other software services and 26.2 percent in data processing and research information services. Although we examine employee and employment in Figure 3, software professionals as self-employed and unpaid-family workers are excluded from our measurement because of difficulties in applying the 50 percent deduction rule for adjusting working time.

[*12] The make matrix is one of supplementary tables of benchmark input-output table published by Ministry of Internal Affairs and Communications (MIC), Japan.

Table. 5 Software Professionals in Non-Software Industry and Limiting Factors

	Original	2.0%		1.0%		0.2%		0.1%	
1.Agriculture, Forestry, Fishery	31	31	(0.0)	31	(0.0)	31	(0.0)	31	(0.0)
2.Coal Mining	3	3	(0.0)	3	(0.0)	3	(0.0)	3	(8.6)
3.Other Mining	10	10	(0.0)	8	(15.4)	2	(83.1)	1	(91.5)
4.Construction	10170	10170	(0.0)	10170	(0.0)	9560	(6.0)	5133	(49.5)
5.Foods	2409	2409	(0.0)	2409	(0.0)	1427	(40.8)	837	(65.2)
6.Textile	468	468	(0.0)	468	(0.0)	311	(33.5)	193	(58.8)
7.Apparel	526	526	(0.0)	526	(0.0)	298	(43.3)	176	(66.5)
8.Woods and Related Products	119	119	(0.0)	119	(0.0)	116	(2.1)	84	(29.2)
9.Furniture and Fixture	422	422	(0.0)	422	(0.0)	247	(41.5)	135	(68.0)
10.Paper and Pulp	745	745	(0.0)	745	(0.0)	413	(44.5)	244	(67.3)
11.Printing and Publishing	5735	5661	(1.3)	4607	(19.7)	1359	(76.3)	685	(88.0)
12.Chemical Products	4147	4147	(0.0)	3822	(7.8)	1048	(74.7)	536	(87.1)
13.Petroleum Refining	332	332	(0.0)	211	(36.6)	42	(87.2)	21	(93.6)
14.Coal Products	72	72	(0.0)	72	(0.0)	19	(73.4)	10	(86.7)
15.Rubber Products	595	595	(0.0)	595	(0.0)	302	(49.2)	153	(74.3)
16.Leather Products	36	36	(0.0)	36	(0.0)	36	(0.0)	29	(20.3)
17.Stone, Clay, Glass	768	768	(0.0)	768	(0.0)	493	(35.8)	345	(55.0)
18.Iron and Steel	1767	1767	(0.0)	1767	(0.0)	536	(69.7)	268	(84.8)
19.Non-ferrous Metal	1273	1273	(0.0)	1273	(0.0)	326	(74.4)	176	(86.2)
20.Metal Products	3468	3468	(0.0)	3468	(0.0)	1864	(46.3)	957	(72.4)
21.Machinery excl Computers	13962	13952	(0.1)	10000	(28.4)	2200	(84.2)	1100	(92.1)
22.Comm. Eq., Computer, and Parts	43067	22270	(48.3)	13414	(68.9)	2766	(93.6)	1383	(96.8)
23.Other Electrical Mach	11962	8619	(27.9)	5171	(56.8)	1273	(89.4)	637	(94.7)
24.Motor Vehicles	5868	5868	(0.0)	5868	(0.0)	1677	(71.4)	839	(85.7)
25.Other Transportation Equipment	1667	1578	(5.3)	1205	(27.7)	331	(80.2)	165	(90.1)
26.Precision Instruments	4335	3908	(9.8)	2149	(50.4)	548	(87.4)	274	(93.7)
27.Other Manufacturing	3666	3521	(4.0)	3285	(10.4)	1219	(66.7)	682	(81.4)
28.Railroad Transportation	818	818	(0.0)	818	(0.0)	531	(35.1)	265	(67.5)
29.Road Transportation	1811	1811	(0.0)	1811	(0.0)	1811	(0.0)	1571	(13.3)
30.Water Transportation	134	134	(0.0)	134	(0.0)	134	(0.0)	80	(40.0)
31.Air Transportation	309	309	(0.0)	309	(0.0)	65	(79.1)	32	(89.5)
32.Storage Facility Service	540	540	(0.0)	540	(0.0)	230	(57.3)	128	(76.3)
33.Communications	16300	5158	(68.4)	2915	(82.1)	640	(96.1)	324	(98.0)
34.Electricity	1144	1144	(0.0)	1144	(0.0)	308	(73.1)	154	(86.5)
35.Gas Supply	441	441	(0.0)	416	(5.6)	102	(76.9)	51	(88.4)
36.Water Supply	200	200	(0.0)	200	(0.0)	200	(0.0)	129	(35.3)
37.Wholesale and Retail	39404	33222	(15.7)	24877	(36.9)	10661	(72.9)	6675	(83.1)
38.Finance and Insurance	16650	16649	(0.0)	10355	(37.8)	3154	(81.1)	1681	(89.9)
39.Real Estate	800	800	(0.0)	800	(0.0)	797	(0.4)	462	(42.2)
40.Education	1451	1451	(0.0)	1451	(0.0)	1451	(0.0)	1320	(9.0)
41.Research	4835	4089	(15.4)	2256	(53.1)	501	(89.6)	251	(94.8)
42.Medical Care	1797	1797	(0.0)	1797	(0.0)	1226	(31.8)	776	(56.8)
43.Other Service	39256	35332	(10.0)	26225	(33.2)	9728	(75.2)	5840	(85.1)
Total	243513	196634	(19.3)	148670	(38.9)	59986	(75.4)	34835	(85.7)

Unit: number of software professionals in non-software industries in 2000 (only employee). Deduction rates by limiting factors are in ( ).
Software industry, government, and not elsewhere classified (nec) are excluded in this table.
Industry classification is aggregated from 217 industries, to which limiting factors are applied.

originals to be reproduced, as described in section 3.3.1. By this assumption, all software professionals in software industry are engaged in the production of originals to be reproduced, to be sold, or to be used in other production. We have to exclude the number of software professionals engaged in the production of originals to be sold, since it is already capitalized as custom software of the purchasers.

As described in the first footnote in section 1, the Japanese benchmark 2000 input-output table does not capitalize own-account software. The costs for producing own-account software are internally described as intermediate consumption, labor costs, operating surplus, and so on, in each industry. In the software industry, output is defined by prepackaged software and custom software, although the inputs may include the costs for developing own-account software. In the benchmark 2000 input-output table, the output share of custom software is 67.4 percent.[13] Here, we consider the 67.4 percent of the number of software professionals to be engaged in the production of custom software in 2000.

In order to estimate software professionals engaged in the production of originals to be own-used in software industry, we apply 0.7 percent for males and 0.1 percent for females, as shares to total employees in 2000. These rates are the shares of software professionals over total employees in total non-software industries.[14] Although the number to be added is small by this adjustment, almost two thirds (66.4 percent) of software professionals in software industry are deducted in 2000.

As a result, the total estimated number of software professionals for own-account software at the aggregate level is 416 thousand (362 thousand males and 53 thousand females) in 2000. It means the net deduction rate of total software professionals is 44.8 percent. As mentioned in section 3, the share of software professionals in the software industry has a clear upward trend. Because of this upward trend and the changes of the above deduction rates, the net deduction rates in total software professionals are 42.8 percent in 1990, 24.2 percent in 1980, 11.1 percent in 1970, respectively. The difference between the adjusted total number of software professionals estimated using the modified BEA's methodology in this section and the harmonized estimates by the OECD Task Force in section 3.2 tends to expand.

3.3.3 Labor and Non-Labor Costs

In order to exclude working time spent on minor revisions and maintenance of own-account software, we use BEA's 50 percent deduction rule, which is also recommended by the OECD Task Force as an upper limit. Based on the average wage of programmers and system engineers by the Basic Survey on Wage Structure (MHLW, Japan), we estimate labor costs for the production of own-account software by industry. Average wages are defined as annual wages per worker for males and females, respectively.[15]

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[13] In the Survey of Selected Service Industries (SSSI) for information service industry by METI (Ministry of Economy, Trade and Industry, Japan), the production share of custom software in the software industry is 85.2 percent in 2000. The production of prepackaged software for business use and games in SSSI are almost same as the benchmark 2000 IO. The gap was mainly from the production of other software, which should be interpreted as the difference of coverage of both statistics.

[14] In 1995, 0.62 percent for males and 0.14 percent for females. This shares increase from 0.15 percent for males and 0.03 percent for females in 1970.

[15] We use the same average wages by sex for each industry. The average wage for females is 11.6 percent lower than the wage for males as programmers and also 20.0 percent lower as system engineers in 2000. For males, wages for system engineers are 39.2 percent higher than the wage for programmers and 25.9 percent higher for females in 2000, as well. Here, we compute average wages in two occupations by sex, using the number of the workers as weights in the benchmark year and

To add social contributions and some allowances, which companies do not directly pay to employees but bears, we compute the expansion rates for wages in information service industry based on benchmark input-output tables. The expansion rates increase from 7.5 percent in the 1960s to 14.6 percent in 2000.

The ratios of non-labor cost over labor cost are computed from the benchmark input-output tables. The ratio in 2000 is 1.508 and the ratios are almost stable within a range of 1.4-1.6 during 1960-2000. Lequiller-Ahmad-Varjonen-Cave-Ahn[2003] reports the ratios are 0.460 in Canada (1995), 1.498 in Denmark (1997), 0.885 in Finland(1995), 0.604 in Italy (1998), 0.995 in Sweden (1999), and 1.017 in the U.S. (1992). In comparison with other OECD counties, the ratio in Japan is at the highest level. At the nominal value, the higher non-labor cost in Japan should be reasonable, reflecting the differences of relative prices among countries. Nomura-Samuels[2003] describes the relative price for labor per worker is 1.120 and the relative price for GDP is 1.443 between the U.S. and Japan in 2000.[16] The GDP price relative to labor costs per worker is 32.3 percentage point higher in Japan in comparison with the U.S.[17]

4 Impacts of Own-Account Software Investment

4.1 Comparison with Other Estimates in Japan

In the previous section, we estimate own-account software investment by industry in Japan. Figure 4 shows the estimated total investment for own-account software based on the modified BEA's methodology and the comparison with the harmonized estimates by the OECD Task Force methodology in section 3.2.[18]

In 2000, the estimated results here is 3107 billion yen, which is 31.3 percent lower than the harmonized estimate. Although we modified the BEA's methodology, the gap of the two estimates is very close to that in the U.S. As shown in Table 4, the BEA's official estimate is 32.4 percent lower than the harmonized estimate in 2000.[19]

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the growth rate of the Theil–Törnqvist wage index.

[16] Relative prices are defined by the purchasing power parities (PPPs) over the exchange rate. If the PPP for a particular input is smaller than exchange rate, the relative price is less than one. In Nomura-Samuels[2003], the PPP for labor input is computed from the cross-classified data, which has 1260 categories, by sex, age, education, class of worker, and industry between the U.S. and Japan.

[17] Our estimates by industry have to be consistently described in our time-series input-output table. The description of the IO table for capitalization of own-account software is discussed in Appendix.

[18] Before 1970, we estimate benchmark values by sex every five years during 1955-1970 based on the number of professional and technical employees, because the number of workers classified into JSCO-06 is not separated in the Population Census. In interval periods between benchmark years, we interpolate the total number of software professionals by sex using the number of workers for programmers and system analysts from the Basic Survey on Wage Structure (MHLW, Japan) at the aggregate level. The interpolated number of software professionals by sex is distributed to industries based on the tentative industry share, which is interpolated values using the benchmark value in each benchmark year and the growth rates of employees by sex by industry in the interval periods.

[19] Here, the ratios of non-labor cost over labor-cost in Japan are higher than that used for the harmonized estimates. As described in section 3.3.2, the total deduction rate in total software professionals has upward trend, from 11.1 percent in 1970 to 44.8 percent in 2000. In 1980, the estimates based on the two methodology are very close, as shown in Figure 4.

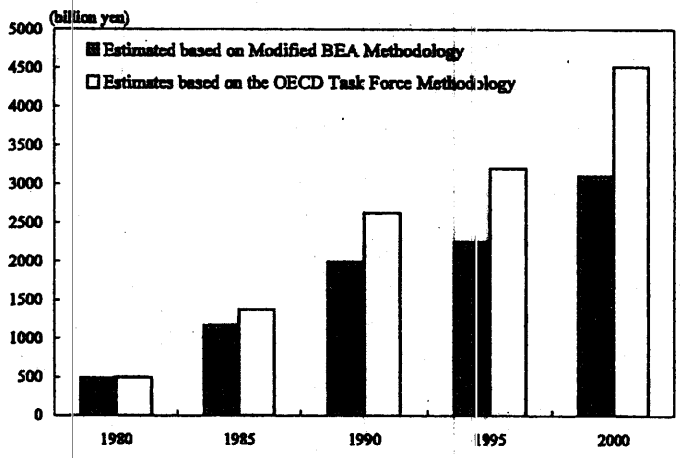

Figure. 4 Own-Account Software Investment in Japan: Comparison of Two Estimates

Table 6 and Figure 5 show our estimated results by type of software, compared to the other Japanese estimates, Miyagawa[2003] and Motohashi[2002], which estimate own-account software investment at the aggregate level.[20] For own-account software shown in the center figure in Figure 5, although our estimate is close to Motohashi's estimate in 1990, his estimate has a different trend in the early 1990s. In 2000, Motohashi's estimate is 13.5 percent lower than our estimate, which is close to Miyagawa's.

From the view of the point of methodology, own-account software estimates in Miyagawa and Motohashi exclude all software professionals in software industry, in order to avoid double-counting of investment in own-account software and prepackaged software. However, as clarified in section 2.1, software originals and reproduction must be conceptually distinguished. Software originals to be reproduced should be recorded as investment by the producers of the copies.

The estimates of custom software investment are very similar after the 1990s in particular, because we can make use of official estimates in the Japanese national accounts after 1980 and the 1985-90-95 linked input-output table. In 1980, the two estimates are about 40 percent lower than that in official national accounts. We set it to the same as the official estimates. For prepackaged software, we have to exclude the embedded software onto other products as GFCF. The trends of prepackaged software investment among three estimates look similar, although the levels in 2000 are different. Probably, Motohashi's estimate does not exclude the embedded software.

As total investment of software shown in Table 6, all of the three estimates in 2000 are almost 10 trillion yen, which is almost 2.0 percent of GDP in Japan. In the U.S., the average annual growth rates of total software investment in current values are 38.7 percent for 1959-79, 15.7 percent for 1979-92, and 12.3 percent for 1992-98 (Parker-Grimm[2000]). Growth rates in our estimates are respectively 29.8 percent,

[20] Our estimates of software investment during 1955-2000, except own-account software estimated in this paper, are described in Nomura[2004] (Chapter-A). Our estimates of custom software investment is set equal to the value in the Japanese official national accounts after 1980, until which the ESRI (Economic and Social Research Institute, Cabinet Office of Japan) estimates it backwardly. Also, prepackaged software investment in our estimates in 2000 is set to the same as that in benchmark 2000 IO table.

Table. 6 Software Investment in Japan: Comparison with Other Estimates

	1960	1970	1975	1980	1985	1990	1995	2000
Custom Software								
Miyagawa	–	9692	44665	246392	1363067	2751524	3575611	6150076*
Motohashi	–	–	54959	269102	1623896	3266059	3575611	6497791
Nomura	1075	26725	114245	430500	1292300	3390200	3561600	6698300
Own-Account Software								
Miyagawa	–	35690	148268	323207	975185	2071658	2328775	3245550*
Motohashi	–	–	188929	359649	1211011	1885213	1856936	2685696
Nomura	1600	62580	219646	481559	1156191	1877514	2267517	3106820
Prepackaged Software								
Miyagawa	–	2793	10552	40890	172924	357371	272734	415195*
Motohashi	–	–	12158	59432	376050	876394	702039	1303861
Nomura	134	3342	13883	48292	183251	449847	424381	649757
Total Software								
Miyagawa	–	48175	203485	610489	2516176	5180553	6177120	9810821*
			(28.8)	(22.0)	(28.3)	(14.4)	(3.5)	(9.3)
Motohashi	–	–	256046	688183	3210957	6027666	6134586	10487348
			(–)	(19.8)	(30.8)	(12.6)	(0.4)	(10.7)
Nomura	2809	92648	347774	960352	2631742	5717562	6253498	10454877
		(35.0)	(26.5)	(20.3)	(20.2)	(15.5)	(1.8)	(10.3)

unit: million yen (nominal). Miyagwa[2003](* 1999 value is written in 2000, in this table.), Motohashi[2002].

Nomura's estimates in custom software is set equal to the official national accounts after 1980.

Nomura's estimates in prepackaged software is set equal to benchmark input-output table in 2000.

Average annual growth rates of nominal values during five years are written in ( ).

16.5 percent, 4.2 percent for the same periods. The growth rates and the diminishing trends are similar between the U.S. and Japan.

4.2 International Comparison

International comparison of shares of own-account software investment to official GDP is in Figure 6(a) and for total software investment to GDP is in Figure 6(b).[*21] In Japan, the share of own-account software to the GDP, which is adjusted to include all software investment, is 0.60 percent in 2000. It is higher than that in the EU countries but Denmark. The U.S. has the highest share of own-account software (0.73 percent) among the countries. As for total software investment in Figure 6(b), Japan has 2.03 percent GDP attributed to software investment. It is slightly lower than that in the U.S. (2.07 percent). Although Sweden has the highest share in total software, we may take the difference of

[*21] In Figure 6, each share in each country is computed, based on the official national accounts, although Japan is the exception. The share in the U.S.(2000) is from the BEA's National Income and Product Accounts (NIPA). The others are from Hermans[2002] for Belgium and from Ahmad[2003] for the other countries.