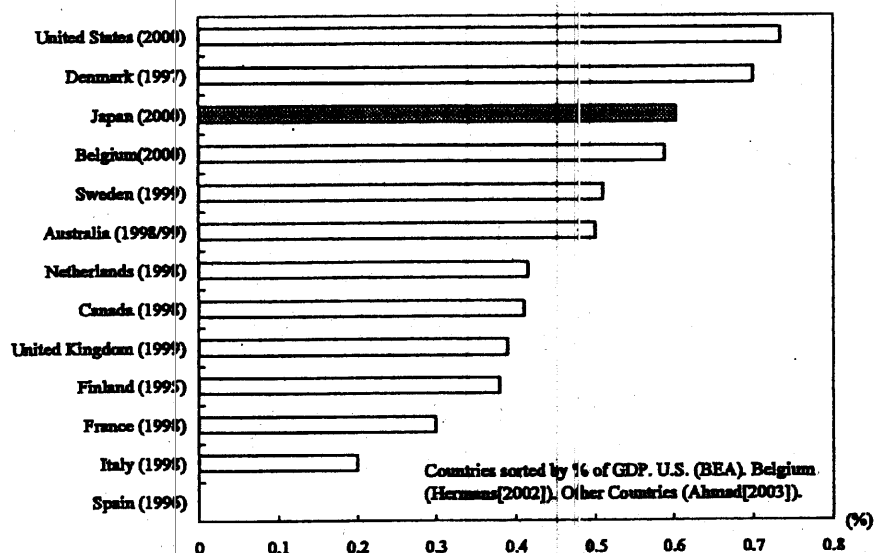Figure. 5 Software Investment in Japan: Comparison with Other Estimates

economic scales into consideration. The relative scale of software investment between the U.S. and Japan may be appropriate.
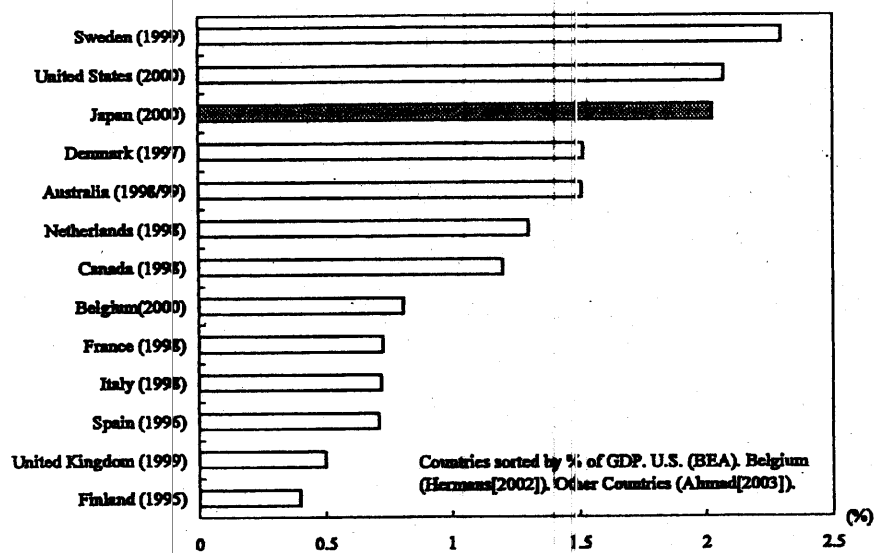
Figure 7 shows the long-term comparison on shares of software investment in GFCF between the U.S. and Japan.[22] In 2000, the share of own-account software investment in GFCF is 3.53 percent in the U.S. and 2.19 percent in Japan. As shown in Figure 7(a), although Japan's share is close to that in the U.S. in the middle of the 1980s, the gap of the shares expands in the 1990s. Also, Japan's share of total software investment to GFCF is 7.37 percent, which is smaller than that in the U.S. (9.97 percent). From the point of the view of GFCF, the gap between the two countries expands in comparison with the relative scale to GDP, reflecting the larger share of tangible assets investment in Japan.

Although the GDP-share of software investment is very close between the U.S. and Japan, the composition by type of software is significantly different. Figure 8 shows the changes of composition of software investment every five years from 1970 to 2000 in the U.S. and Japan. In 1970, own-account software has the largest share in software investment and prepackaged software is minor. We can indicate that the composition in both countries is very similar between the two countries in 1970.

(a) Own-Account Software Investment

United States (2000)
Denmark (1997)
Japan (2000)
Belgium(2000)
Sweden (1999)
Australia (1998/99)
Netherlands (1990)
Canada (1990)
United Kingdom (1999)
Finland (1995)
France (1990)
Italy (1990)
Spain (1995)

Countries sorted by % of GDP. U.S. (BEA). Belgium (Hermans[2002]). Other Countries (Ahmad[2003]).

(%)

0   0.1   0.2   0.3   0.4   0.5   0.6   0.7   0.8

(a) Own-Account Software Investment

(b) Total Software Investment

Sweden (1999)
United States (2000)
Japan (2000)
Denmark (1997)
Australia (1998/99)
Netherlands (1995)
Canada (1995)
Belgium(2000)
France (1995)
Italy (1995)
Spain (1996)
United Kingdom (1999)
Finland (1995)

Countries sorted by % of GDP. U.S. (BEA). Belgium (Hermans[2002]). Other Countries (Ahmad[2003]).

(%)

0   0.5   1   1.5   2   2.5
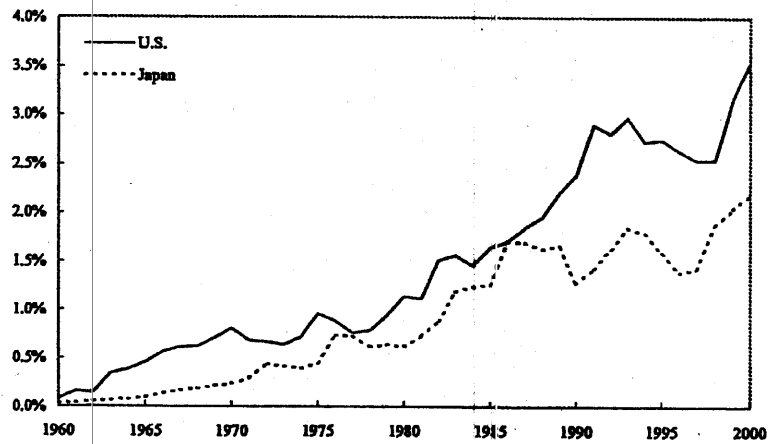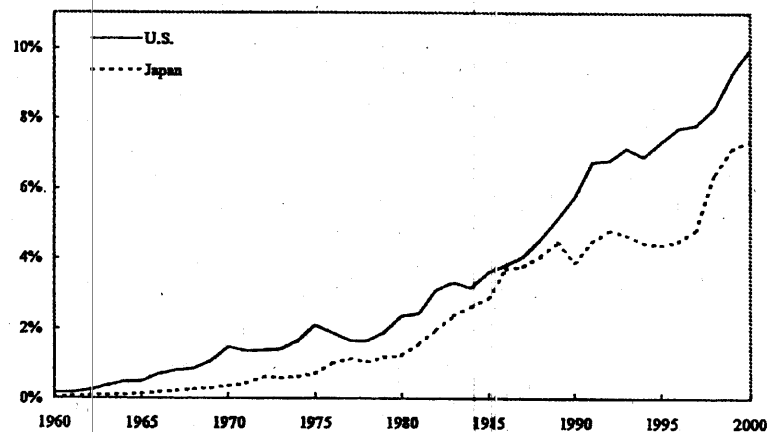
(b) Total Software Investment

Figure. 6   Share of Software Investment in GDP: International Comparison

(a) Own-Account Software Investment

(b) Total Software Investment

Figure. 7   Share of Software Investment in GFCF: the U.S. and Japan

The share of own-account software decreases in both countries through the 1970s and the 1980s. In the U.S., the diminution of the share of own-account software is reflected by the rapid expansion of prepackaged software. On the other hand, in Japan, the diminution is mainly reflected by the expansion of custom software. In 2000, custom software occupies the largest portion, the share of which is almost two thirds of the total software investment in Japan. The difference in the direction of outsourcing of software production in the U.S. and Japan may be partly interpreted as the difference of business custom, like the difference of the share of embedded software. Partly, the difference of the software market conditions in both countries may explain some of the difference, because some software in Japanese market is required to be compatible with the use of Japanese language.
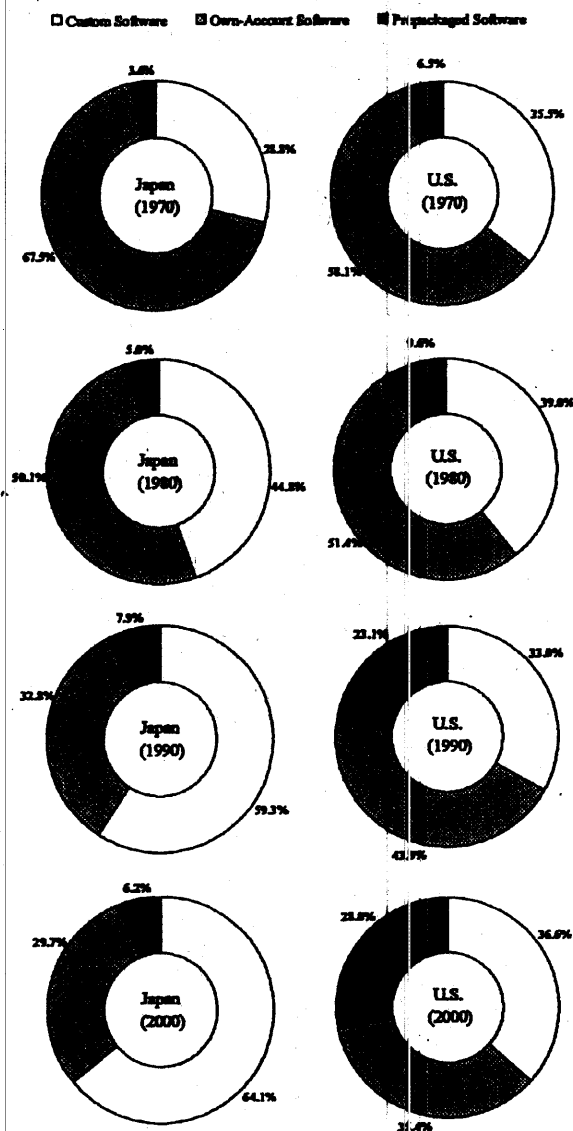
20

Figure. 8   Composition of Software Investment: Comparison between the U.S. and Japan

4.3   Software Investment by Industry

Figure 9 represents the long-term industry composition of own-account software investment for manufacture and electrical machinery industry, which has the biggest share within manufacture. Manufacture occupies 42.8 percent of own-account software investment on average in the 1960s. The share gradually decreases to 39.3 percent in 1970s, 34.9 percent in 1980s, and 30.7 percent in 1990s. In 2000, 74.0 percent of own-account software investment is by service sectors. The exception industry within manufacture is electric machinery, which holds 13-20 percent shares in these periods. Figure 10 shows

the details of own-software investment by industry in 2000."[23] Software industry has the largest investment in own-account software, as shown in Figure10. It produces 1.1 trillion yen in 2000, which is 36.4 percent of the total.
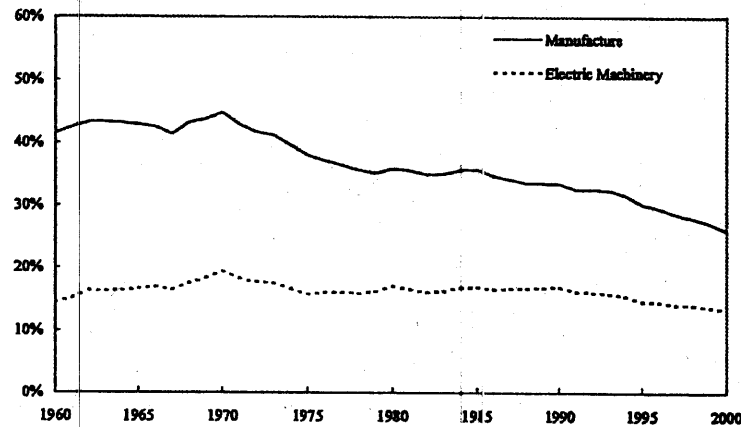

Figure. 9 Industry Share of Own-Account Software Investment in Japan

Figure 11-13 represent the shares of own-account software and software investment in GFCF by industry in 1970, 1990, and 2000 in Japan. In each figure, industries are sorted by the order of the own-account investment share. By capitalizing own-account software, there are large impacts on investments in IT producers, like communications equipment, computers, and electronic components, relatively. In 1970, the share of own-account software investment in GFCF by industry in Figure 11(a) is similar to the share of total software investment in Figure 11(b), since custom software and prepackaged software have a minor portion in 1970, as shown in Figure 8 at the aggregate level.

In 1990, we find a clear difference between Figure 12(a) and Figure 12(b) for finance and insurance. Although this industry is in the fourth highest position in terms of own-account software share in 1970, it descends to the seventh position in 1990, and twelfth position in 2000. Clearly, the finance and insurance industry moves from own-account software to custom-software, while it expands overall software investment during these periods.

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[23] In Figure 10, we define GFCF by industry excluding household residence and almost all of infrastructure, which are included as aggregate GFCF in Figure 7.
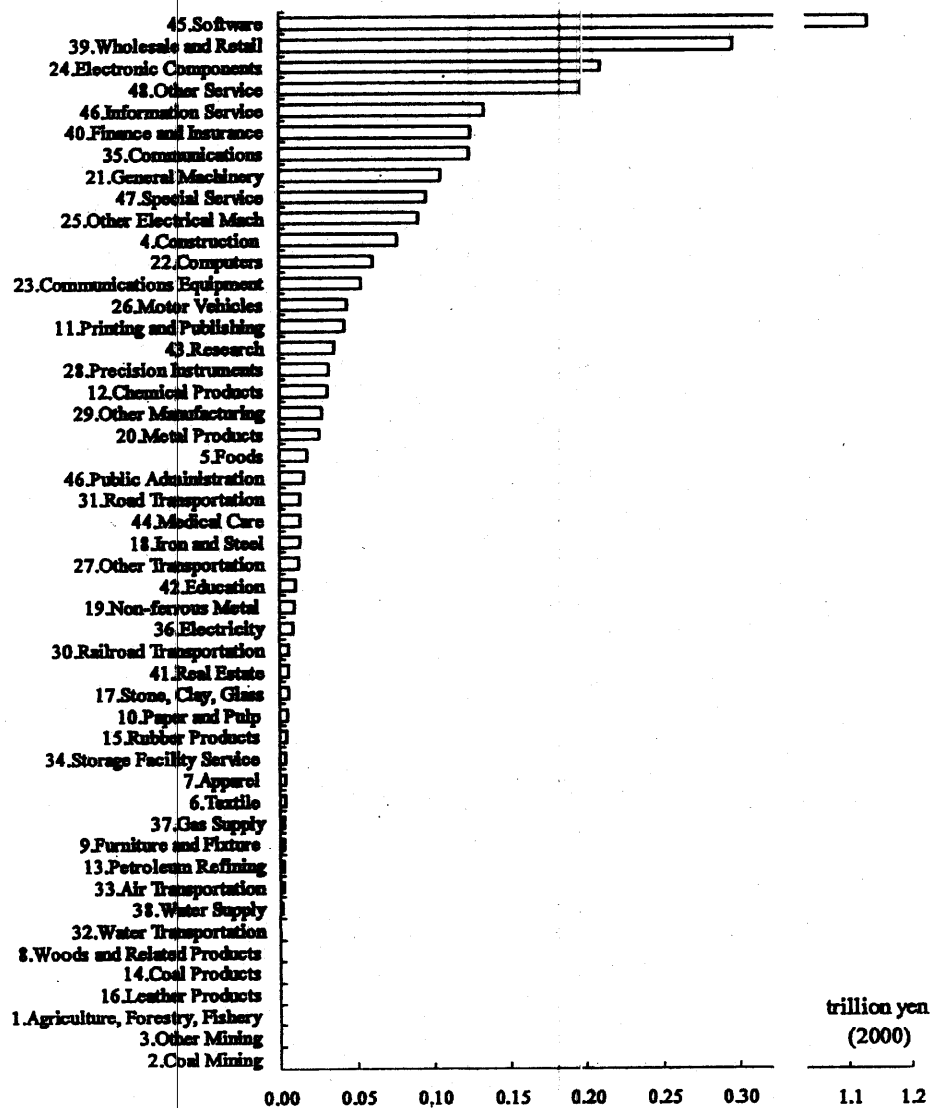
45.Software
39.Wholesale and Retail
24.Electronic Components
48.Other Service
46.Information Service
40.Finance and Insurance
35.Communications
21.General Machinery
47.Special Service
25.Other Electrical Mach
4.Construction
22.Computers
23.Communications Equipment
26.Motor Vehicles
11.Printing and Publishing
43.Research
28.Precision Instruments
12.Chemical Products
29.Other Manufacturing
20.Metal Products
5.Foods
46.Public Administration
31.Road Transportation
44.Medical Care
18.Iron and Steel
27.Other Transportation
42.Education
19.Non-ferrous Metal
36.Electricity
30.Railroad Transportation
41.Real Estate
17.Stone, Clay, Glass
10.Paper and Pulp
15.Rubber Products
34.Storage Facility Service
7.Apparel
6.Textile
37.Gas Supply
9.Furniture and Fixture
13.Petroleum Refining
33.Air Transportation
38.Water Supply
32.Water Transportation
8.Woods and Related Products
14.Coal Products
16.Leather Products
1.Agriculture, Forestry, Fishery
3.Other Mining
2.Coal Mining

trillion yen
(2000)

0.00   0.05   0,10   0.15   0.20   0.25   0.30   1.1   1.2
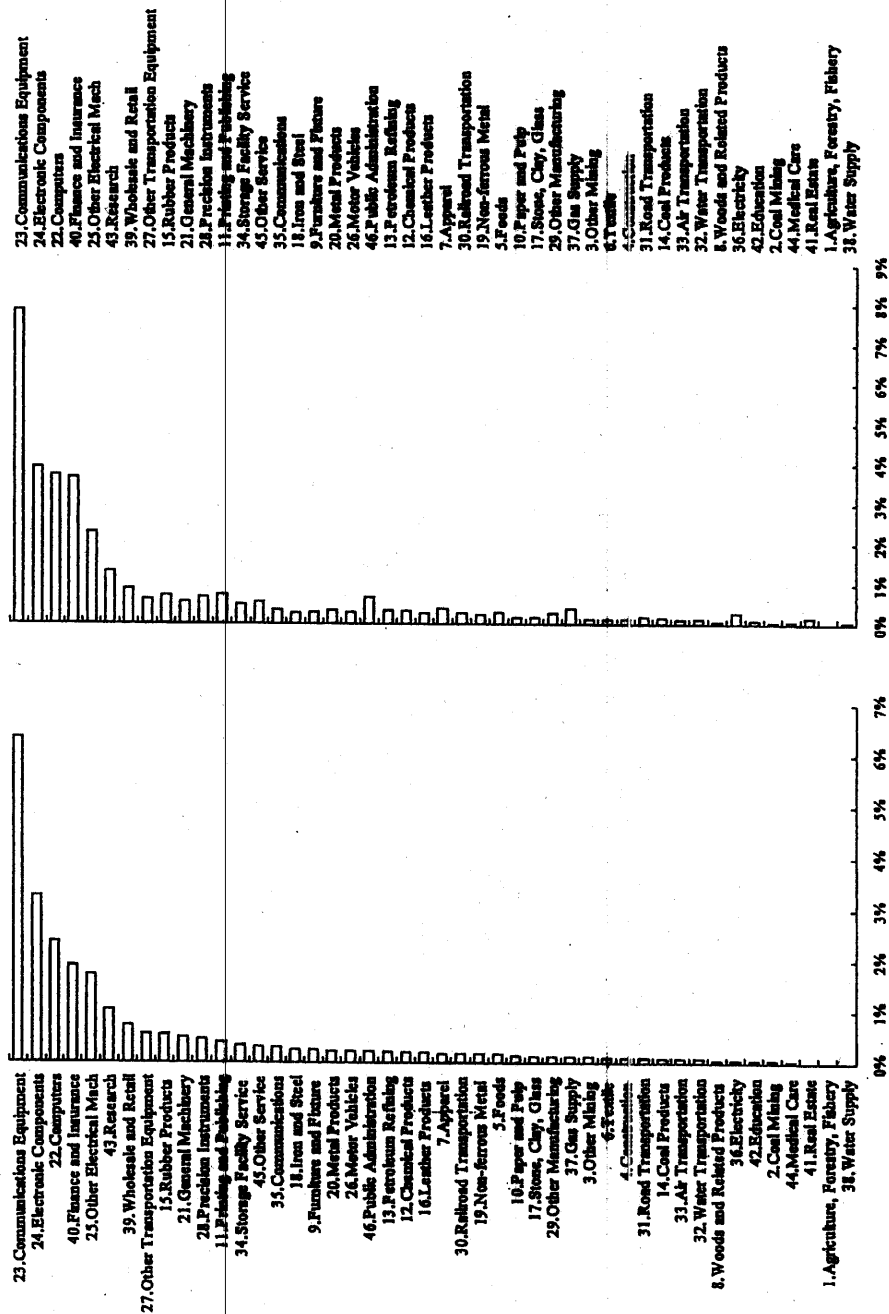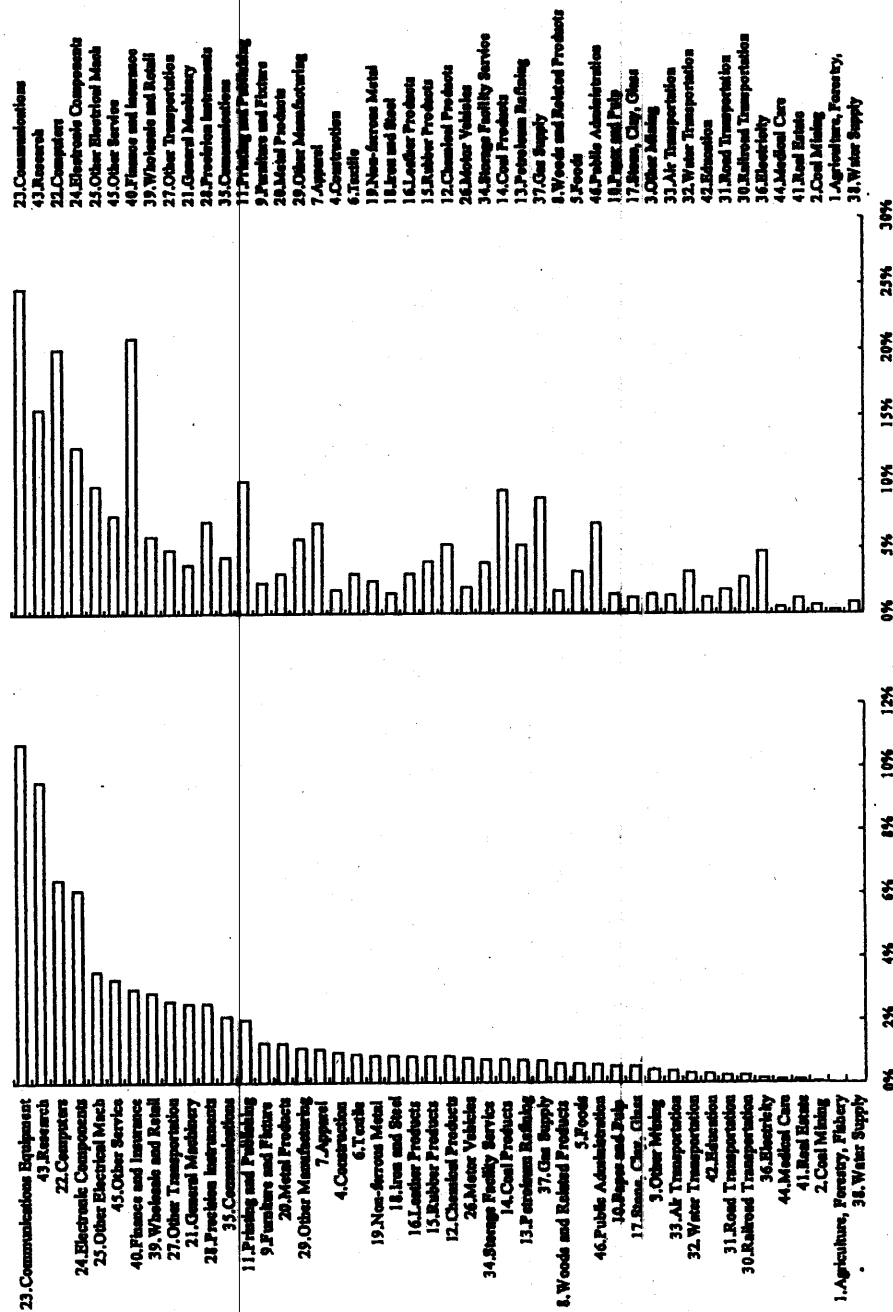
Figure. 10   Own-Software Investment by Industry in 2000, Japan

23

(a) Own-Account Software Investment

(b) Total Software Investment

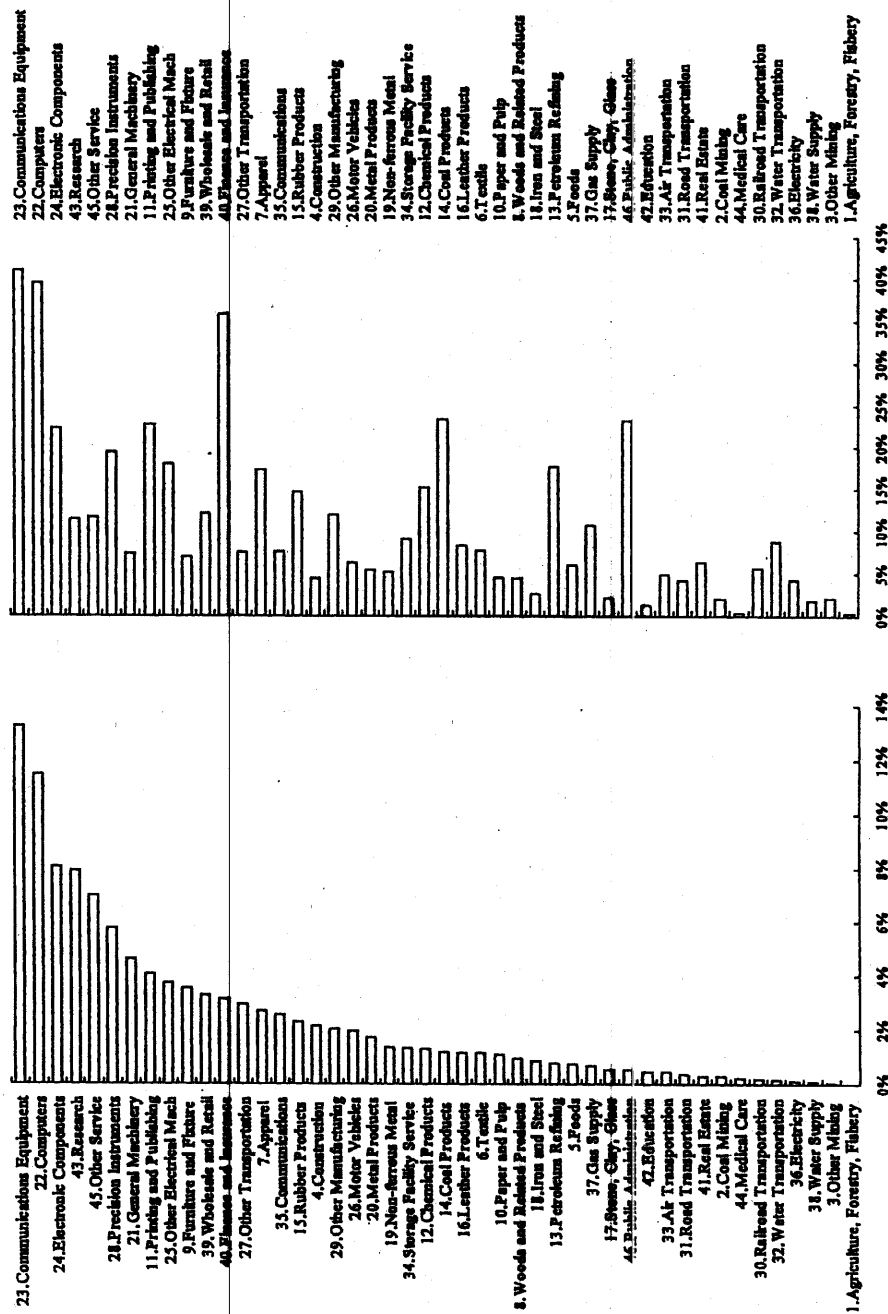Figure. 11   Share of Software Investment in GFCF by Industry in 1970, Japan

Industry labels (both charts):

23.Communications Equipment
24.Electronic Components
22.Computers
40.Finance and Insurance
25.Other Electrical Mach
43.Research
39.Wholesale and Retail
27.Other Transportation Equipment
15.Rubber Products
21.General Machinery
28.Precision Instruments
11.Printing and Publishing
34.Storage Facility Service
45.Other Service
35.Communications
18.Iron and Steel
9.Furniture and Picture
20.Metal Products
26.Motor Vehicles
46.Public Administration
13.Petroleum Refining
12.Chemical Products
16.Leather Products
7.Apparel
30.Railroad Transportation
19.Non-ferrous Metal
5.Foods
10.Paper and Pulp
17.Stone, Clay, Glass
29.Other Manufacturing
37.Gas Supply
3.Other Mining
6.Textile
4.Communication
31.Road Transportation
14.Coal Products
33.Air Transportation
32.Water Transportation
8.Woods and Related Products
36.Electricity
42.Education
2.Coal Mining
44.Medical Care
41.Real Estate
1.Agriculture, Forestry, Fishery
38.Water Supply

(a) Own-Account Software Investment

(b) Total Software Investment

Figure. 12   Share of Software Investment in GFCF by Industry in 1990, Japan

25

(a) Own-Account Software Investment

(b) Total Software Investment

Figure. 13   Share of Software Investment in GFCF by Industry in 2000, Japan

26

As shown in Figure 7(a), although the impact of capitalizing own-account software is 2.19 percent of share of GFCF at the aggregate level in 2000, the impacts for communications equipment and computers exceed 10 percent. In comparison with the aggregate impact (7.37 percent) of total software in GFCF as shown in Figure 7(b), the three industries, communications equipment, computers, and finance and insurance, have the impacts of more than 30 percent of GFCF. Seven industries have more than 20 percent shares of software; electronic components, printing and publishing, coal products, and public administration, in addition to the others. Impacts of software investment for the above industries are very significant for their technological changes as capital inputs.

5 Software Stock

5.1 Price and Depreciation Rate

Next, we estimate capital stock by type of software, based on our estimates of software investment in this paper. To measure capital stock by the perpetual inventory method, we examine depreciation rates and prices for software. In current Japanese tax law, the service life of software is set to 5 years, except software to be reproduced and software to be used in research and development activity, which has 3 years service lie.[24] Under the 1.65 declining-balance depreciation rate, the corresponding geometric depreciation rate for a 5-year service life is 33.0 percent.

The BEA uses a 3-year service life for prepackaged software and a 5-year service lie for custom software and own-account software and the 3-year service life is the same as that used in the U.S. tax law (Parker-Grimm[2000]). Lequiller-Ahmad-Varjonen-Cave-Ahn[2003] reports the survey for asset service lives for software in national accounts of some OECD countries. Czech Republic, Finland, France, Italy, and United Kingdom use a 5-year service life. Spain uses a 4-year service life and Netherlands uses the shortest service life; a 3-year life for all types of software. The service life in Canada is the same as that in the U.S. Adding to Canada and the U.S., Australia, Denmark, and Sweden assume the 30-40 percent lower service life for prepackaged software than that for custom software and own-account software.[25] The range for the software service life among countries is 3-6 years, with a median of 5. In this paper, we use a 33.0 percent geometric depreciation rate, which corresponds to a 5-year service life. The sensitivities of different rates of depreciation will be examined in section 5.2.

Prices of software also should be noted. As Jorgenson-Ho-Stiroh[forthcoming] discusses the possibility that the price indexes used to deflate software investment fail to hold quality constant, the BEA's estimates in the U.S. also are in the process to accurately capture quality change in software. In the 2003 comprehensive revision by the BEA, the price indexes for custom software and own-account software are identical, and are defined by a weighted average of the input cost index with the NIPA prepackaged

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[24] Software began to be treated as depreciable intangible fixed assets in the 2000 revision of Japanese tax law. Before 2000, own-account software had not been defined as fixed assets from the point of the view of tax law, although some own-account software had been capitalized in business accounts.

[25] Assumed depreciation distributions are geometric in Sweden and the U.S., hyperbolic in Australia, and straight line in other countries.