software price index.[26]

Ahmad[2003] indicates a big diversity in software price estimates in some OECD countries. In Sweden, the software price increases by about 6 percent annually during 1995-2000. On the other hand, the software price in Australia decreases by annually 6 percent in the same period and the BEA's revised price for total software (0.8 percent annual decline) is between the two estimates.

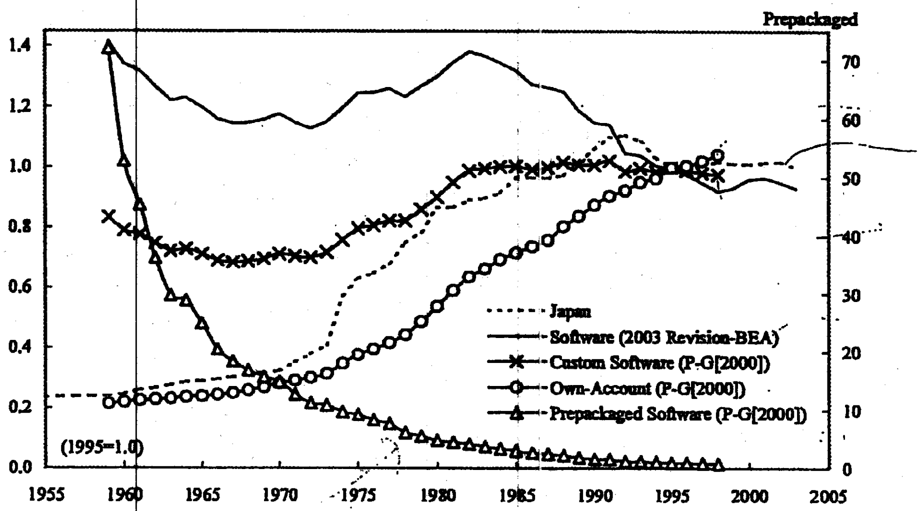

Figure. 14 Software Investment Price: Comparison between the U.S. and Japan

Figure 14 shows prices for total software in the U.S. revised in 2003, for three types of software reported by Parker-Grimm[2000] in the U.S., and for custom software in Japan. Japan's price for custom software is estimated by the Corporate Service Price Index (CSPI, Bank of Japan) after 1995, which is measured by the labor cost. Japanese official national accounts also uses this price index and estimates it backwardly until 1980. In Figure 14, we estimate it until 1955 using the cost index of computer services. Here, we consider it to be a cost index for software production in Japan. Prices by type of software reported by Parker-Grimm[2000] are estimates before the 2003 comprehensive revision by the BEA. We can consider the price for own-account software by Parker-Grimm to be a cost index for software production in the U.S., which is defined as a simple average of programmer labor cost and non-labor inputs. The price for custom software is defined by a weighted average of the price indexes for own-account software and prepackaged software.

If we use the cost index as total software price in Japan, the trends in the 1970s and the 1980s differ between the U.S. and Japan. In comparison with cost indexes in both countries, the movements of both indexes are similar. The gap in the total software price is generated from the very rapid decline of

[26] See the postscript added in June 2004, in Grimm-Moulton-Wasshausen[2003]. Until this revision, the price index for own-account software was defined by the BEA's input cost index consisting of compensation cost indexes and an intermediate inputs cost index. For custom software, the price index was defined as a weighted average of the price indexes for own-account software and prepackaged software, where the weights are arbitrarily selected as 75 percent for own-account software and 25 percent for prepackaged software (Parker-Grimm[2000]).

prepackaged software prices in the U.S., which is shown in Figure14 (right axis), which holds quality constant. The annual average rate of decline in prepackaged software price is 11.0 percent in the 1980s and 8.7 percent during 1990-98 in the U.S.

So far, in Japan, we don't have a good estimate for prepackaged software that holds quality constant. In this paper, we use the cost index, which is used for custom software in the Japanes national accounts, for all types of software. In order to examine the sensitivity of the results to the change of deflators, we also compute harmonized indexes, as a tentative approximation. Based on the relationship between cost indexes, $p^{U}_{c.i.}$ in the U.S. and $p^{J}_{c.i.}$ in Japan, we compute the harmonized index for prepackaged software p^{J}_{pre} for Japan, the growth of which is defined by the $\Delta \ln p^{J}_{pre} = \Delta \ln p^{U}_{pre} + (\Delta \ln p^{J}_{c.i.} - \Delta \ln p^{U}_{c.i.})$, where p^{U}_{pre} is the price of prepackaged software in the U.S. Like the BEA's revised methodology, we also define the harmonized prices for custom software and own-account software in Japan as a weighted average of the harmonized index for prepackaged software and the cost index. Figure 15 shows the comparison between the revised total software price in the U.S. and the harmonized price for total software in Japan, which is defined as a Theil-Törnqvist index of types of software with their nominal investment values as weights. We examine the sensitivity of the results to the harmonized prices in section 5.2.

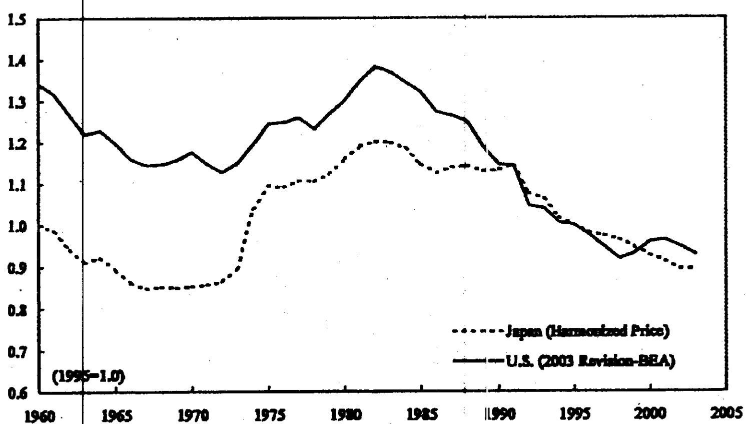

Figure. 15 Harmonized Software Investment Price in Japan

5.2 Measurement Results of Software Stock

To measure software capital stock, we examine four scenarios. First, for depreciation, the 33 percent and 55 percent geometric depreciation rates are assumed. Second, there are two options for prices, the cost index for all types of software and the harmonized indexes for each type of software. Table 7 and Figure 16 represent the estimated results of software stock corresponding to the four scenarios. Shares to fixed capital stock are in ( ) and shares to total capital stock, including land and inventory, are in [ ] in Table 7.[*27]

[*27] Here, capital stock is composed of one hundred two assets; ninety tangible fixed assets, five intangible assets including three types of software, four types of land, and three types of inventories. Measurement of capital stock, except software, is based

Table. 7 Software Stock and the Share to Total Capital Stock

	Own-Account Software				Total Software			
	33% δ		55% δ		33% δ		55% δ	
	C.I.	H.I.	C.I.	H.I.	C.I.	H.I.	C.I.	H.I.
1960	14.5	3.7	10.8	2.6	27.3	7.0	19.7	4.5
	(0.01)	(0.00)	(0.01)	(0.00)	(0.02)	(0.00)	(0.01)	(0.00)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
1965	71.9	21.4	54.2	16.5	103.1	29.7	76.0	22.3
1970	405.1	143.6	308.3	110.4	574.7	197.5	441.7	153.2
	(0.10)	(0.04)	(0.08)	(0.03)	(0.15)	(0.05)	(0.11)	(0.04)
	[0.02]	[0.01]	[0.02]	[0.01]	[0.04]	[0.01]	[0.03]	[0.01]
1975	1146.3	529.3	759.9	368.3	1700.2	764.6	1149.6	541.7
1980	1941.1	1167.6	1237.4	776.3	3347.8	1965.7	2241.4	1365.2
	(0.23)	(0.14)	(0.15)	(0.09)	(0.40)	(0.24)	(0.27)	(0.16)
	[0.08]	[0.05]	[0.05]	[0.03]	[0.14]	[0.08]	[0.09]	[0.06]
1985	3320.7	2371.3	2253.7	1644.3	6978.0	4815.0	4834.0	3397.1
1990	5761.7	4882.4	3682.4	3236.2	14656.2	12282.8	9848.1	8555.3
	(0.44)	(0.37)	(0.28)	(0.25)	(1.11)	(0.93)	(0.75)	(0.65)
	[0.18]	[0.16]	[0.12]	[0.10]	[0.47]	[0.39]	[0.32]	[0.27]
1995	6902.7	6830.6	4313.1	4343.9	18363.2	18174.4	11323.7	11416.0
2000	7628.4	8181.9	4829.4	5289.0	25168.1	27507.5	16432.2	18362.2
	(0.41)	(0.44)	(0.26)	(0.28)	(1.35)	(1.47)	(0.88)	(0.99)
	[0.20]	[0.21]	[0.13]	[0.14]	[0.65]	[0.71]	[0.43]	[0.48]

unit: billion yen (1995 constant price). δ means a geometric depreciation rate. Stock is defined as an average of values in the beginning and ending periods.

C.I. is deflator defined by cost index.

H.I. is harmonized price index, computed basing relative cost indexes between the U.S. and Japan.

Shares to fixed capital stock is in ( ) in every ten years.

Shares to total capital stock, including land inventory, is in [ ] in every ten years.

In case of 33 percent geometric depreciation rate (δ), own-account software stock are 7.6 trillion yen estimated using the cost index and 8.1 trillion yen using the harmonized prices in 2000, which amounts to about 0.4 percent of fixed capital stock and about 0.2 percent of total capital stock. As our estimated stock is evaluated 1995 constant price, the estimated values by both price indexes are similar around 1995 in cases with same δ. In 1970, the own-account software stocks estimated using the harmonized prices is 65 percent lower than that using the cost index. For total software stock, 25.2 trillion yen estimated using the cost index and 27.5 trillion yen using the harmonized indexes in 2000.

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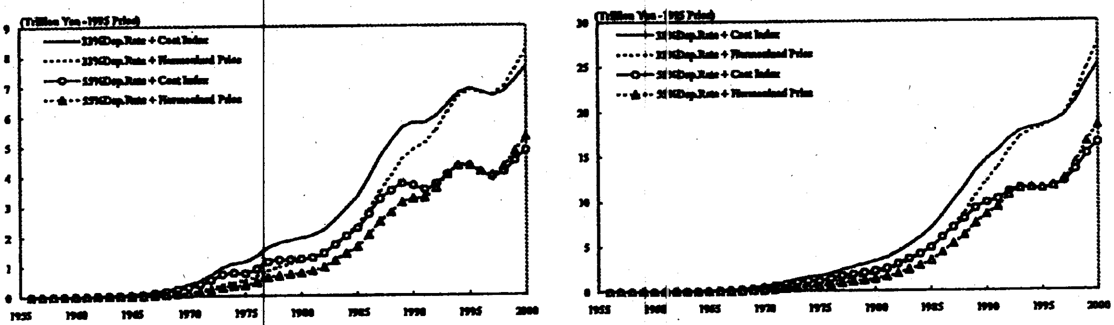
on the revised estimates of Nomura[2004]. The initial year for perpetual inventory method is 1955, when the large-scale survey for national wealth took place in Japan. We estimate initial stock for tangible assets based on the 1955 National Wealth Survey. For software, we estimate the initial stock by type of software, based on assumptions of constant growth rate for each type of software by industry and constant depreciation rate before 1955; as the ratio is the real investment value in 1995 over a sum of average growth rate of real investment during 1955-60 and a depreciation rate.

As shown in Table 8, the growth rate of own-account software stock estimated by the cost index is lower than that using the harmonized indexes. From 1995 to 2000, although the growth rate of stock using the cost index for own-account software is 2.0 percent, the stock using the harmonized prices increases annually by 3.6 percent. For total software, the annual growth rates are 6.3 percent using the cost index and 8.3 percent using the harmonized index. Since Japan has much smaller share of prepackaged software relative to the U.S., as shown in Figure 8, the impacts through the revaluation of prepackaged software is relatively small. Impacts depend on how prices for custom software and own-account software are defined to consider the quality changes in these software.

In the case of the 55-percent-δ, own-account software stock is about 36 percent lower in 2000 than that with the 33-percent-δ. Also in 1970, the stock levels with 55-percent-δ is about 24 percent lower. The changes in δ shift the levels of the estimated software stocks, but have a relatively small impact on the growth rates, as shown in Table 8.



(a) Own-Account Software Investment

(b) Total Software Investment

Figure. 16 Software Stock: Four Scenarios

Table. 8 Growth Rates of Software Stock

	Own-Account Software				Total Software			
	33% δ		55% δ		33% δ		55% δ	
	C.I.	H.I.	C.I.	H.I.	C.I.	H.I.	C.I.	H.I.
1960-65	32.0	35.1	32.2	37.2	26.6	28.8	27.0	32.0
1965-70	34.6	38.0	34.8	38.1	34.4	37.9	35.2	38.5
1970-75	20.8	26.1	18.0	24.1	21.7	27.1	19.1	25.3
1975-80	10.5	15.8	9.8	14.9	13.6	18.9	13.4	18.5
1980-85	10.7	14.2	12.0	15.0	14.7	17.9	15.4	18.2
1985-90	11.0	14.4	9.8	13.5	14.8	18.7	14.2	18.5
1990-95	3.6	6.7	3.2	5.9	4.5	7.8	2.8	5.8
95-2000	2.0	3.6	2.3	3.9	6.3	8.3	7.4	9.5

unit: annual average growth rate(percentage).

C.I. is the cost index. H.I. is the harmonized price index.

As mentioned in section 5.1, we use a 33-percent-δ and a cost index for all types of software. It should be of note that the estimated growth rate of own-account software stock may be underestimated if we consider the quality adjustment of Japan's software prices in the future.

6 Conclusion

In this paper, we measure own-account software investment in Japan as suggested by the OECD Task Force methodology at the aggregate level and the BEA's methodology at the industry level. We conclude that the scale of own-account software investment is 0.60 percent of GDP in 2000 in Japan. This share is 0.13 percentage points lower than that in the U.S. The share of total software investment to GDP is 2.03 percent, which is almost the same as that in the U.S. (2.07 percent), reflecting the larger share of custom software relative to other countries.

We find a significant difference of the composition by type of software between the U.S. and Japan in this paper. In 2000, the investment share of prepackaged software is 28.0 percent of total software in the U.S., in comparison with 6.2 percent in Japan. Also, the difference in the composition may be also important for the consideration of the constant-quality price for software investment. So far, the BEA computes software prices by type of software and carefully examines the prepackaged software price to hold quality constant. There is a big difference of price trends among type of software in the U.S. Although, it is hard to justify that software quality change depends on the type of software. Reconciliation of quality changes among the types of software should be taken into consideration.

Additionally, it may be important to consider the consistency between prices for non-embedded prepackaged software, which is defined as investment of prepackaged software, and embedded prepackaged software, which is defined as investment in other tangible assets. With further conceptual sophistication of software investment, including the relationship between own-account software and other activities still not capitalized, like R&D, OJT, advertisement, and so on, we continue to accumulate empirical results to improve the measurement of the price, effective service life, and depreciation distribution of software.

A Capitalizing on Input-Output Table and Consistency with Other Data

Let us think of the input-output table, which comprises the use-table (commodity*industry), make-table (industry*commodity), and x-table (commodity*commodity). In the use-table without capitalization of own-account software, the costs for producing own-account software are internally described as intermediate consumption, compensation of employees (L), consumption of fixed capital (D), operating surplus (O), and so on, in each industry. To capitalize own-account software, we should modify this description of the input-output table.

The description depends on the definition of output. Industry classification is defined by the establishments, of which the company consists. Based on a main product of establishment, each of the different establishments within one company is classified into different industries, individually. All outputs, which can include different products, produced by one establishment is defined as the output of the same industry, to which the establishment belongs. The make-table describes the product-mix by industry.

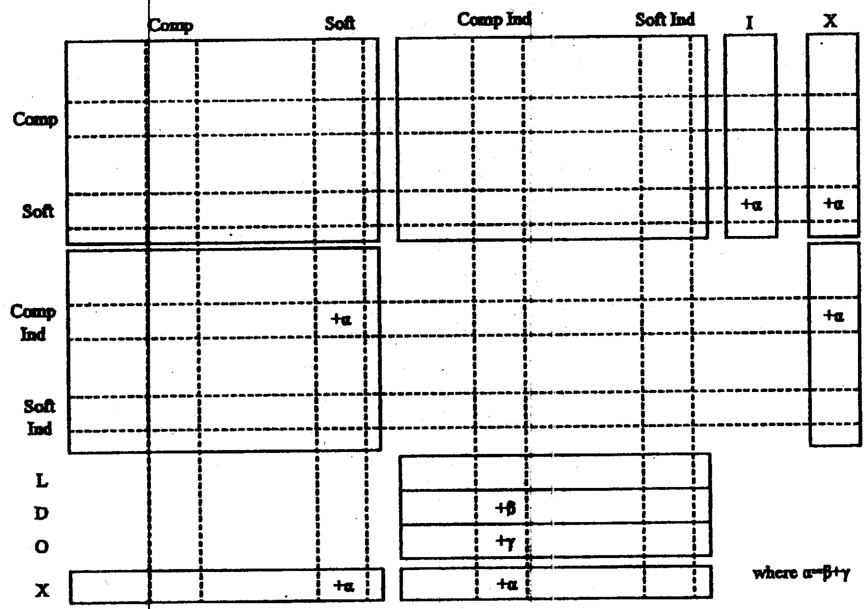


Figure. 17 Capitalization of Own-Account Software: Approach-1

For example, if the computer manufacturing industry develops software originals not to be sold, we have two options to define the output of the computer industry: the industry outputs including the production of own-account software or excluding it. Figure 17 shows the rebalanced IO table after capitalization of own-account software, if we define the output in computer industry as the product-mix of computer and own-account software. The original output in computer industry should be increased by the produced value (α) of own-account software. The input balance of computer industry in the use-table is retained by the increase (β) of the consumption of fixed capital for own-account software and the increase (γ) of the operating surplus, which is defined by $\gamma = \alpha - \beta$. At the make-table, the value

(α) produced by computer industry is described as the increase of the production of software. Finally, the increase of software production is capitalized as additional investment of the computer industry. The increase of value added ($\beta + \gamma$) is the same as the increase of final demand (α) in a total economy, in which the GDP also increases by α.

The second approach to describe capitalization of own-account software is shown in Figure 18. In this case, the original output value of the computer industry remains unchanged since the output is defined excluding the production of own-account software in computer industry. Here, in order to produce own-account software, the labor cost is y_2, consumption of fixed assets is y_3, operating surplus is y_4, and the other intermediate consumptions are y_1. The production value is defined as the total cost, $\alpha = y_1 + y_2 + y_3 + y_4$. In computer industry, these costs are reduced by the cost for producing computer. Instead, capital service cost for using own-account software should be described. In terms of the first approach in Figure 17, that is β and γ. The value (α) of own-account software is counted to be produced by the software industry. The increased value (α) is described at the diagonal in the make-table and capitalized in investment from software production. The increase of value added, which is equalized with the increase of final demand (α), are y_1 in the computer industry and $y_2 + y_3 + y_4$ in the software industry.[*28]

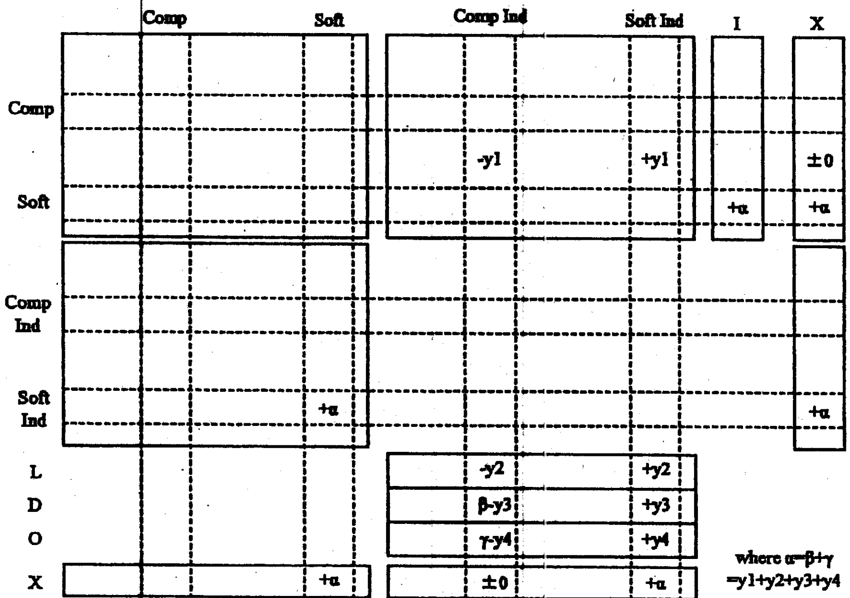


Figure. 18 Capitalization of Own-Account Software: Approach-2

Probably, the first approach is easier for rebalancing IO. On the other hand, we have to redefine industry output prices even in non-software industries, which should be defined as the aggregate prices

[*28] In our example, for simplicity, we neglect own-account software produced by government sector. If it is included, gross output of the government sector decreases by the value of own-account software and increases by the value of consumption of own-account software. Redefinition of government output leads to an adjustment of government consumption in final demand. In the economic system, increase of the GDP is (increase of investment for own-account software;α) - (own-account software produced by government) + (consumption of own-account software of government).

of commodities between the original outputs and the own-account software produced by the industry, based on the product mixes in the make-matrix. Also, the measured productivities in non-software industries are sensitive to the change of the price for own-account software, which may be frequently revised.

In order to avoid the product-mix problem in non-software industries, the second approach may be preferable. In this case, there is no need to redefine industry output prices in non-software industries. However, it makes it difficult to keep the consistency with detailed labor inputs. Labor inputs are cross-classified by sex, age, education, class of worker, and industry, like Jorgenson-Ho-Stiroh[forthcoming] for the U.S. productivity accounts and Nomura[2004] for Japan. If we don't have a category of occupation for labor inputs or we don't reconcile software professionals for producing own-account software to the categories in labor inputs, the generated bias may be not negligible, especially, for some IT related industries like computer manufacturing and communication.

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