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How can we estimate the quality deterioration with time in the rental service of office buildings in Japanese Services Producer Price Index?

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Index

1. Outline of the price index for the rental service of office buildings in the SPPI : Pricing method and Quality adjustments

1-1. Outline of "Office space rental"

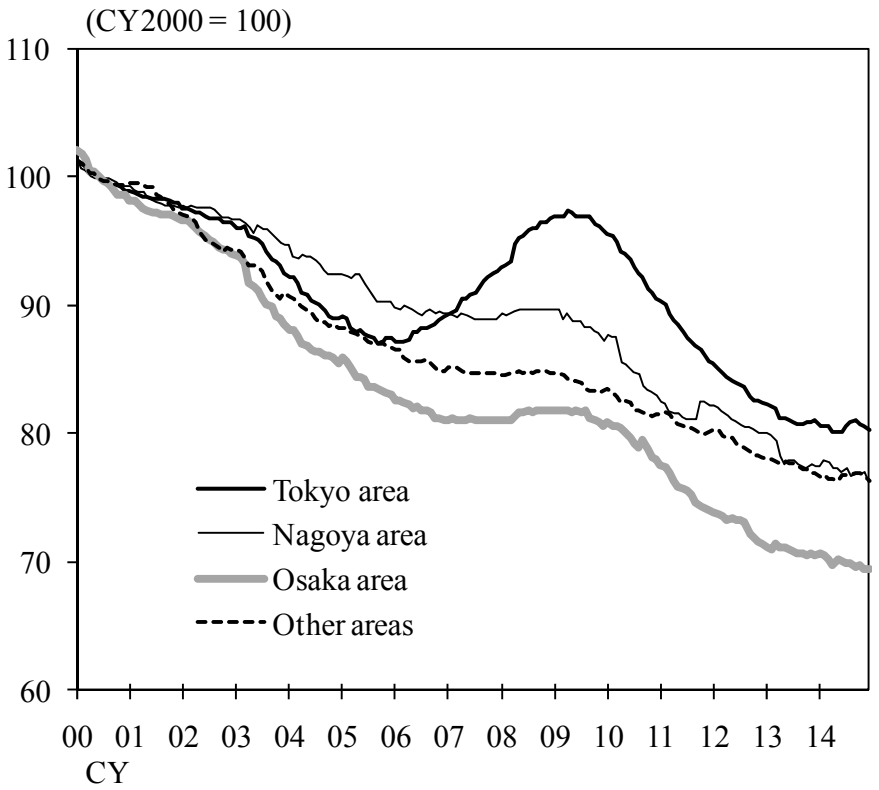
- ✓ The Bank of Japan, which compiles the Services Producer Price Index (SPPI), surveys price for rental service of office buildings in the Subgroup "Office space rental." The weight for "Office space rental" accounts for 4.4 percent of the overall index.
- ✓ There is wide variation in office rents by region, so the "Office space rental" in the SPPI is based on 4 geographic pricing areas.

Outline of "Office space rental" in SPPI

Items	Weights (%)	Areas	Number of sample prices
Tokyo area	3.20	Five prefectures including Tokyo in Kanto area	130
Nagoya area	0.21	Two prefectures including Nagoya in Chubu area	32
Osaka area	0.64	Four prefectures including Osaka in Kinki area	66
other areas	0.33	None of those above	61
Total	4.38		289

(note1) The number of sample prices are as of January 2015.
(note2) The indexes are not reflected of quality adjustments.

Price indexes for different areas



1-2. Pricing method

- ✓ "Office space rental" in the SPPI follows the actual rent paid by renters.
- ✓ It covers all tenants, including both new and renewed contracts.
- ✓ The average rent per square meter has been surveyed with a sample building fixed.

Characteristics of pricing method

(1) It covers the actual rent paid by renters.
—— Not advertised list prices for new tenants.

(2) It includes both new and renewed contracts.
—— It is superior to other surveys in terms of coverage.

Calculation of sample prices

$$\textit{The average rent per square meter} = \frac{\textit{Total income from a office building}}{\textit{Total floor space in operation of a office building}}$$

1-3. Quality bias in the index of "Office space rental"

- ✓ Four factors have great influence on office rent: (i) location, (ii) size, (iii) attached equipment ,and (iv) age.
- ✓ The factors of (i) location, (ii) size, and (iii) attached equipment can be fixed by specifying a sample office building.
- ✓ As for the (iv) age, it is necessary to consider the fact that the value of office renting service declines as a office building ages with time.

⇒ Quality adjustments are required to correct the aging bias.

(i) Location

(ii) Size

(iii) Equipment

(iv) Age

1-4. Bank of Japan's approach

✓ The Bank of Japan has adjusted for quality deterioration with time in office buildings since 2010.
- — To our knowledge, it is the first attempt in the world to adjust for quality changes for aging bias of office buildings.
- — In the U.S., the indexes for rent and rental equivalence of residential dwellings in the CPI have been adjusted for aging bias. However, it is more difficult to adjust for aging bias of renting "commercial real estate".

Outline of the method for quality adjustment

- Estimate the depreciation rates of offices for different age
- Survey the age for each sample office
- Apply different depreciation rates to individual sample offices according to age

↓

Adjust for aging bias in the rental service of office buildings

2. Why is it difficult to measure the depreciation rate for office buildings?

2-1. Simple approach : Hedonic quality adjustments

✓ In order to measure the aging bias of office building, "Hedonic method" is a simple and reasonable approach.

Hedonic quality adjustments

- Based on a Hedonic regression model, analyze the relationship between office rent and various characteristics(age, location, size, equipment and so on).
- Then, estimate the regression coefficient of age (=aging effects)

Example of Hedonic quality adjustment

- In the U.S., Hedonic quality adjustments have been applied for the house rent in the CPI.

$$\ln rent_{i,t} = \alpha_t + \gamma_1 age_{i,t} + \gamma_2 age_{i,t}^2 + \beta X_{i,t} + u_{i,t}$$

- Quality adjustments for aging bias are conducted using the regression coefficient of age.

2-2. Difficulties associated with Hedonic quality adjustments (1)

✓ However, it is difficult to employ Hedonic method for the following three reasons.

(1) Hedonic regressions require a large amount of sample data

- In general, office buildings have more varieties of quality than residential structures.

  → In order to estimate hedonic rent regression model, considerable amount of samples are required.

  — In the U.S. CPI, the number of samples amounts to 20,000.

- In practice, however, it is difficult to collect such a huge amount of data continuously.

  — The Subgroup "Office space rental" of the SPPI has greater coverage than other Subgroups, but still only covers around 300 prices.

2-2. Difficulties in Hedonic quality adjustments (2)

(2) Estimations with high frequency are necessary.

- The regression coefficient of age is likely to vary over time
  → It is necessary to update regression models frequently.
  —— In the U.S., CPI carries out regressions once a year. The results show that the regression coefficient of age has changed with time.

(3) The regression function of Hedonic approach is complicated.

- Most existing studies were based on the assumption that "depreciation proceeds at a fixed rate." In other words, they assumed that the asset value declines in an exponential manner with time.
- However, statistical test does not necessarily support it.

↓

Instead of Hedonic quality adjustments,
alternative quality adjustment method is necessary!

3. The methodology for the estimation of depreciation rates developed by Bank of Japan : Basic concept

3-1. Quality measurements using asset value approach (1)

✓ It is possible to count the decrease in the total asset value of office building as the decrease in the quality office renting service provides.

- The office rent is the sum of the rental fee for "land," "building frame" and "attached equipment" (such as elevators, light fixtures, air-conditioning equipment, security systems).
- Assume that the quality of rental service of office buildings is proportional to the total asset value of "land", "building frame," and "attached equipment".

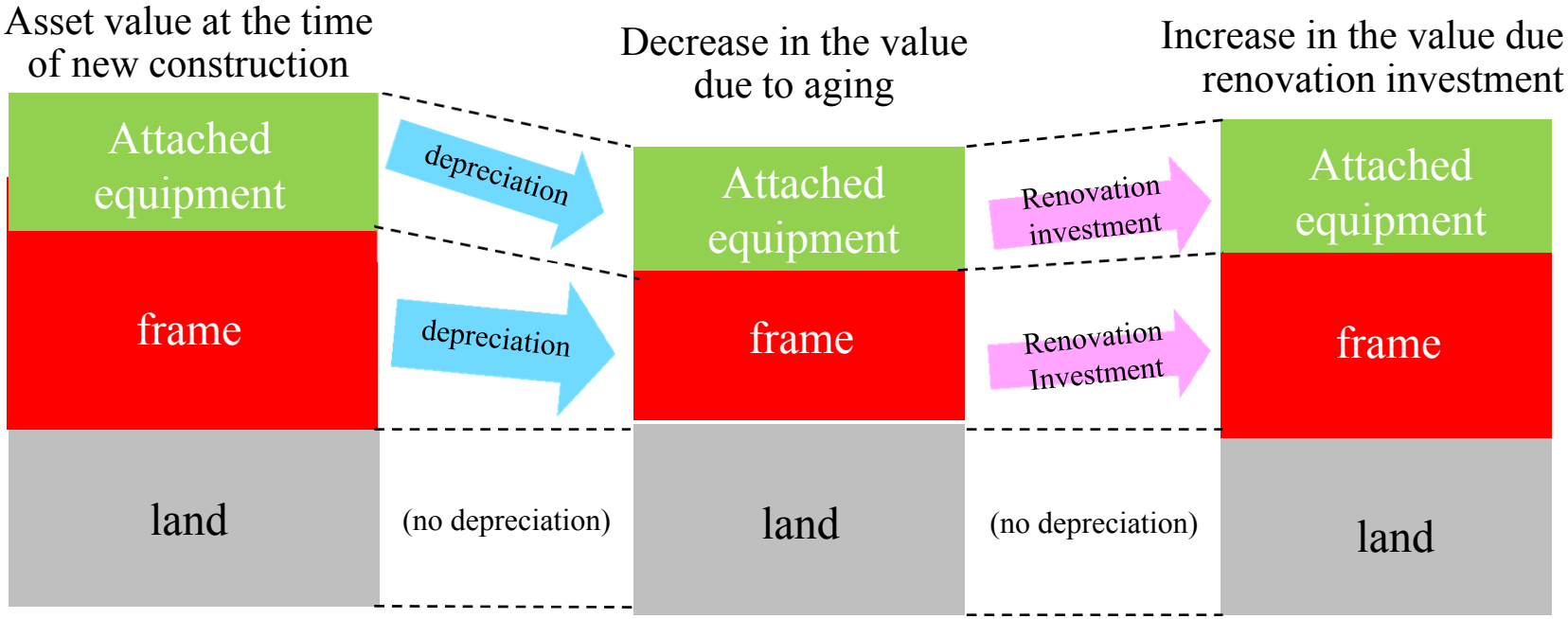
- Based on the assumption, the decrease in the quality that office renting service provides can be regarded as equivalent to the decrease in the total asset value of office building (capital depletion).

$$\textit{Depreciation rate for offices} = \frac{\textit{decrease in the asset value (structure and attached equipment)}}{\textit{asset value of office building (structure, attached equipment and land)}}$$

3-1. Quality measurements using asset value approach (2)

- ✓ First, set the initial asset value, by estimating expenses for obtaining land, building frame and attached equipment by area, at the time of construction.
- ✓ Second, assume that the value of building frame and attached equipment depreciate every year at a fixed rate.
- ✓ In addition, take into account the impact of renovation investment on asset value.

Changes in the asset value



3-2. Advantages of the asset value approach (1)

(1) It helps to represent complicated depreciation patterns, instead of fixed rate.

- ✓ It is possible to view that the depreciation rate for office building is the sum of quality deterioration of three assets, with different depreciation rates.

(2) External data are available as declining-balance rate for frame and equipment.

- ✓ It is available to use the declining-balance rates used to estimate net stocks of SNA, as well as those derived from related literature.
- ✓ Therefore, it is not necessary to estimate depreciation rates from scratch.

→ The asset value approach can be applied to other rental services.

(3) It is possible to incorporate value changes due to renovation investment.

- ✓ As years go by, the asset value declines at a slower pace due to renovation investment.

→ Our approach makes it possible to reflect such value changes.

3-2. Advantages of the asset value approach (2)

(4) It is possible to adjust for quality variability depending on location or scale.

- ✓ The asset value approach can adjust for quality variability across offices by area or location, in view of (i)land prices, (ii) differences in floor space by area (resulting from regulations on height or floor-area ratio of building).
  - —— For example, in Tokyo, where land prices are relatively high, land accounts for a relatively high proportion of total asset value. The proportions of building frame and attached equipment, both of which depreciate with time, are comparably small. Therefore the depreciation rate is low.

(5) It reflects time series variations in depreciation rates.

- ✓ When land prices are soaring, the depreciation rate becomes lower. Conversely, when land prices are declining, the rate becomes higher.

4. The methodology for the calculation of depreciation rates developed by Bank of Japan : Practical methodology

4-1. Depreciation rates for building frame (1)

- ✓ The depreciation rate for building frame is 5.0 percent per year, based on the research *Saita & Higo [2010]* .
- ✓ The depreciation rate in Japan is approximately twice that of the United States (BEA). It indicates that the service life of offices in Japan is shorter than that in the U.S., which can perhaps be attributed to Japan's strict earthquake-resistance standards.

Estimates by *Saita & Higo [2010]*

Size of office building	Depreciation rates for building frame
Small	5.0%～5.4%
Middle	4.9%～5.6%
Large	4.6%～5.0%

→ 5.0% per year

Declining-balance rate for fixed assets by JSNA and BEA

JSNA：5.98% per year

(excluding residential structures, 2009)

⇒ The rate is a bit higher.

BEA(Hulten and Wykoff [1981])：2.47% per year

(Office buildings
- Private nonresidential structures)

⇒ The rate is lower because it didn't consider strict safety standards in Japan and renovation in the U.S..

4-1. Depreciation rates for building frame (2)

✓ *Saita & Higo [2010]* measured depreciation rates by using the data of office rent, considering several factors that have great impact on rent.

Outline of study by Saita & Higo [2010]

(1) Data

Office rent in Tokyo districts, 2,700 prices (at the timing of new advertisement, as of April 2007)

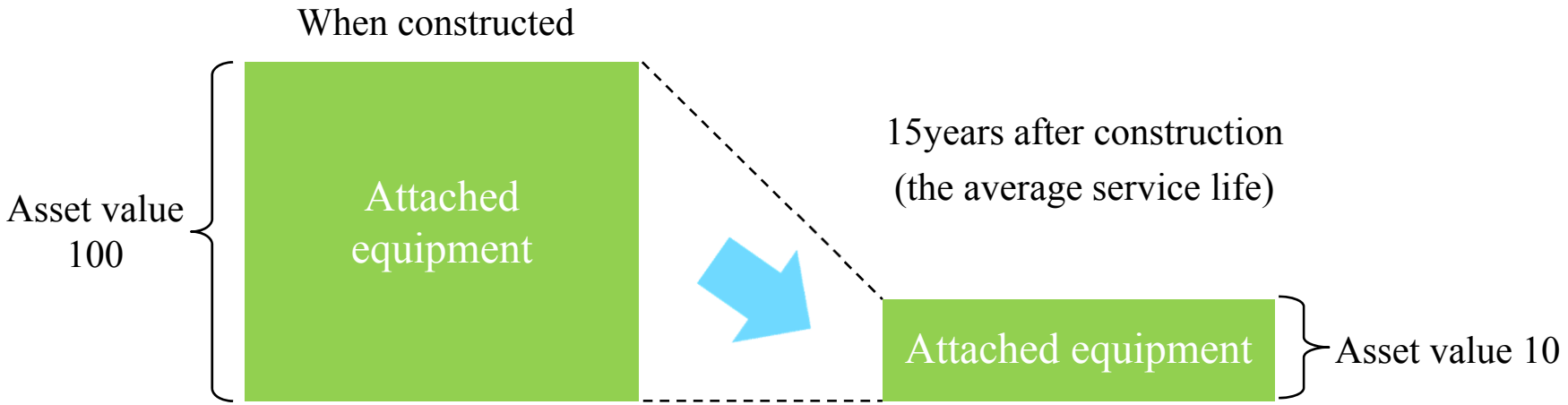
(2) Characteristics

1. Use the office rent, instead of the office transaction prices.
2. Consider the quality differences depending on attached equipment or location.
3. Adjust the bias caused by retirements assets by adding estimated rent for removed offices
4. Consider the impact of land and equipment on the office rent.
5. Adjust the quality changes due to renovation investment

4-2. Depreciation rates for attached equipment

✓ The depreciation rate for attached equipment is 14.2 percent per year. It is calculated based on the assumption that the value of equipment declines to 10% of its initial value 15 years (the average service life) after construction.

Calculation of the depreciation rate for attached equipment



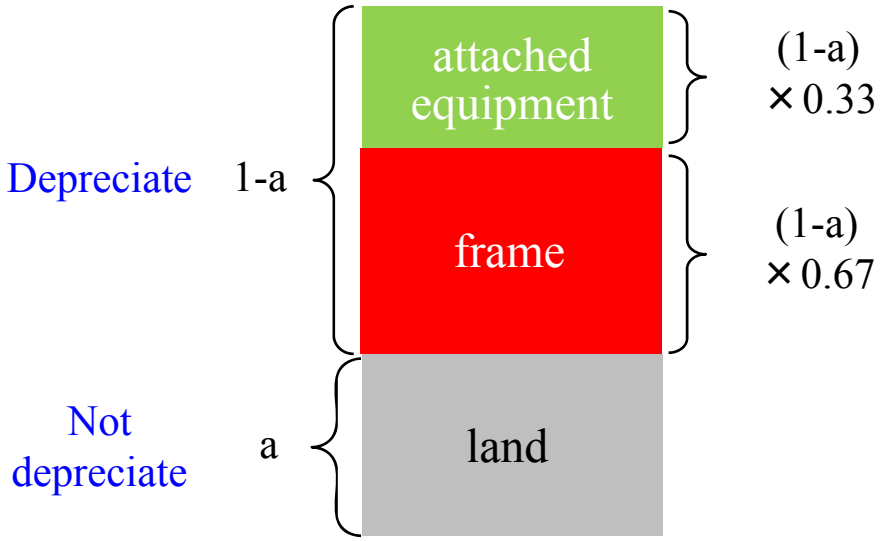
$(1\text{-depreciaion rate})^{15} = 0.1 \Rightarrow$ Depreciation rate =14.2% per year

(Reference) Japan Facility Management Association

4-3. Proportions of land, frame and equipment

✓ The proportions of land, building frame and attached equipment are set based on the following procedures.
(1) Calculate the proportion of land (not depreciate) by using related statistics.
(2) Fix the ratio of building frame and attached equipment to be 67 to 33.

Proportions of the asset value of offices



Proportions for different areas（2015）

(%)

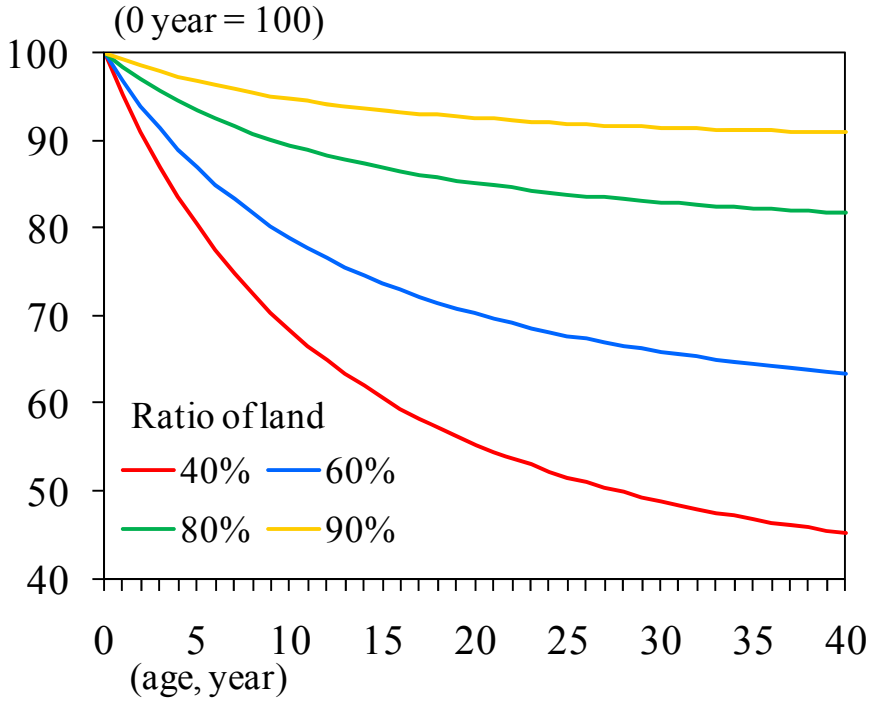
	Land	Frame	Attached equipment
Tokyo area	54.3	30.6	15.1
Nagoya area	40.6	39.8	19.6
Osaka area	38.7	41.1	20.2
Other areas	38.8	41.0	20.2

✓ Calculate the proportion of land(a) referring to land prices and statistics relating to property.
✓ Keep the ratio of building and attached equipment to be 67 to 33.

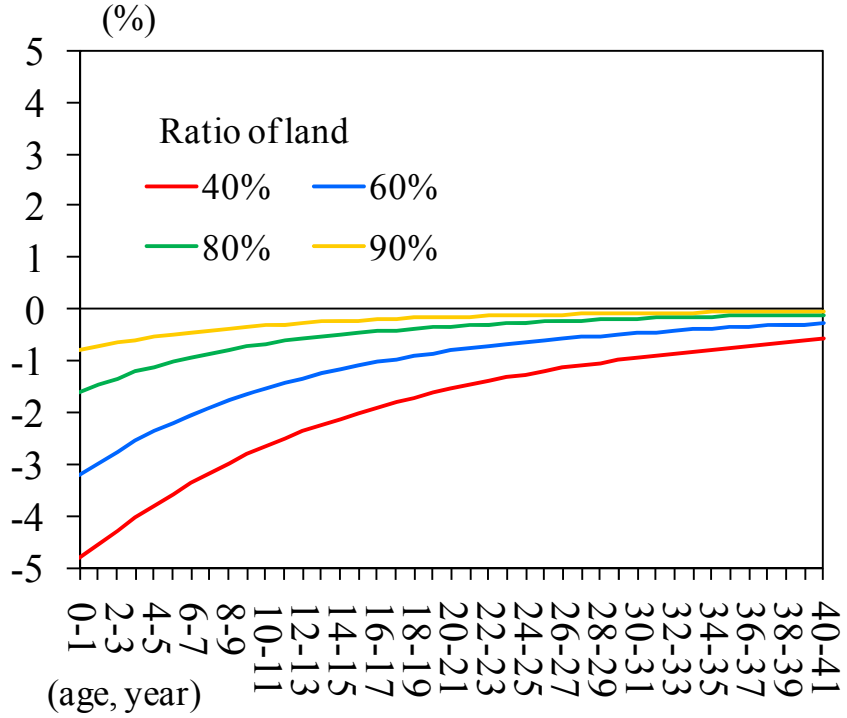
4-4. Differences in depreciation rates due to the proportion of land

✓ As the ratio of land is smaller, the office value declines more and the depreciation rate becomes larger. It's because ratios of building frame and equipment that deteriorate with time account more percentage for the total.

Value of offices



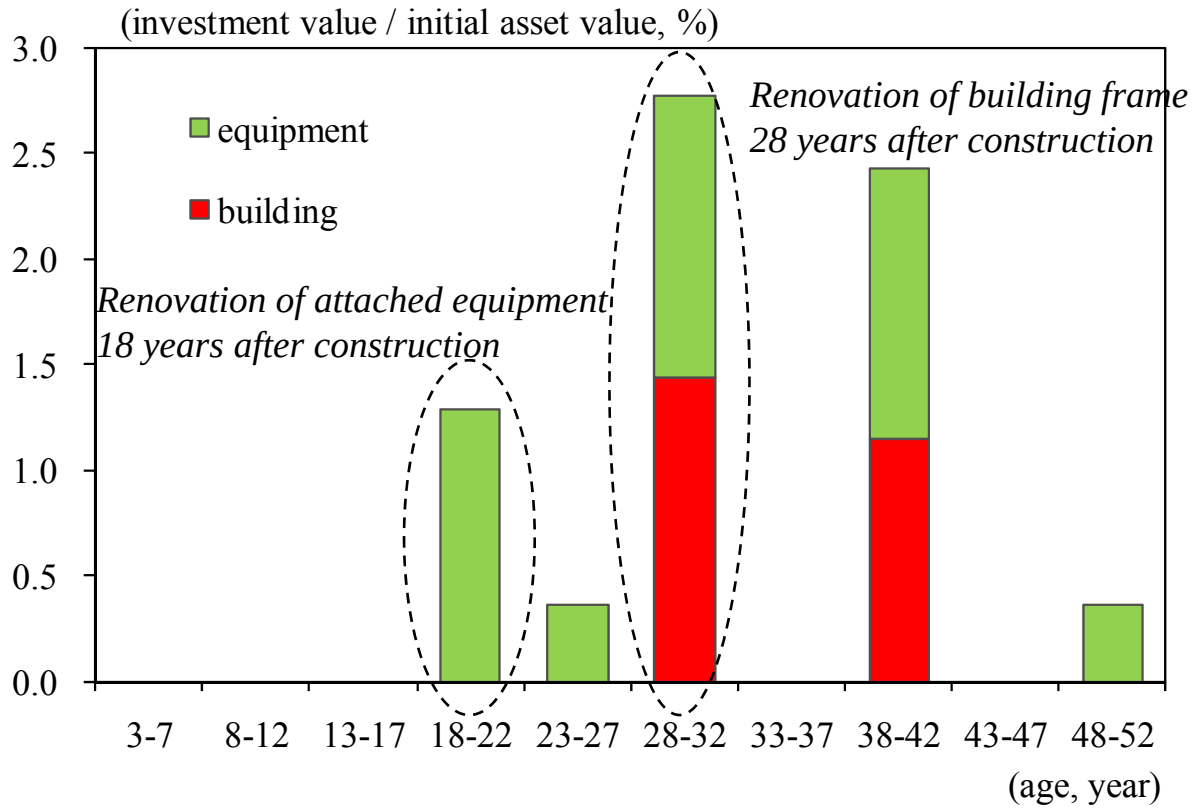
Depreciation rates



4-5. Renovation investment

- ✓ First, estimate the average renovation investment patterns for offices according to different age.
- ✓ Next, based on the assumption that renovations are conducted according to those patterns, estimate the asset value and the depreciation rates for offices.

Average patterns of renovation investment

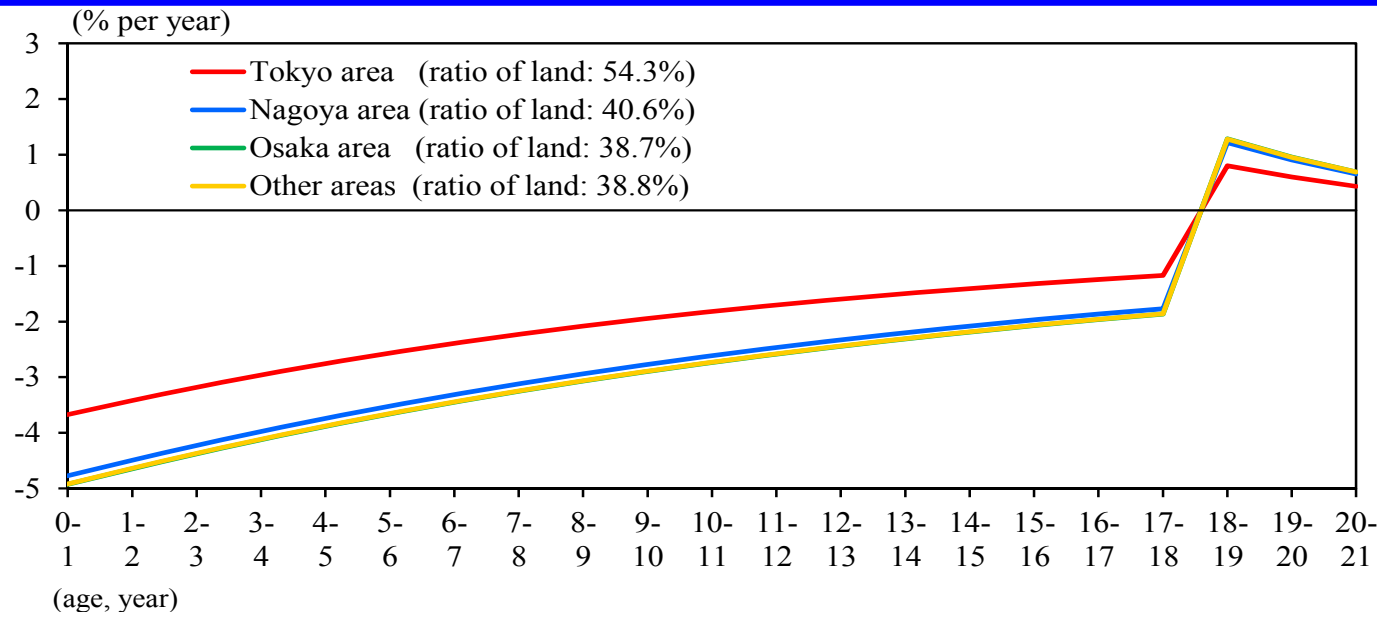


5. Depreciation rates in the SPPI

5-1. Depreciation rates for different age

- ✓ In all areas, depreciation rates diminish as years go on.
  - —— This is because the value of building frame and attached equipment declines at an early stage, whereas the land value remains unchanged which in turn accounts for a greater proportion of total value.
- ✓ The net depreciation rate has been turned plus due to renovation investment 18 years after construction.
- ✓ The depreciation rate is low in Tokyo area with a large ratio of land. On the other hand, where the ratio of land is smaller than that in Tokyo, like in Osaka area, the rate is high.

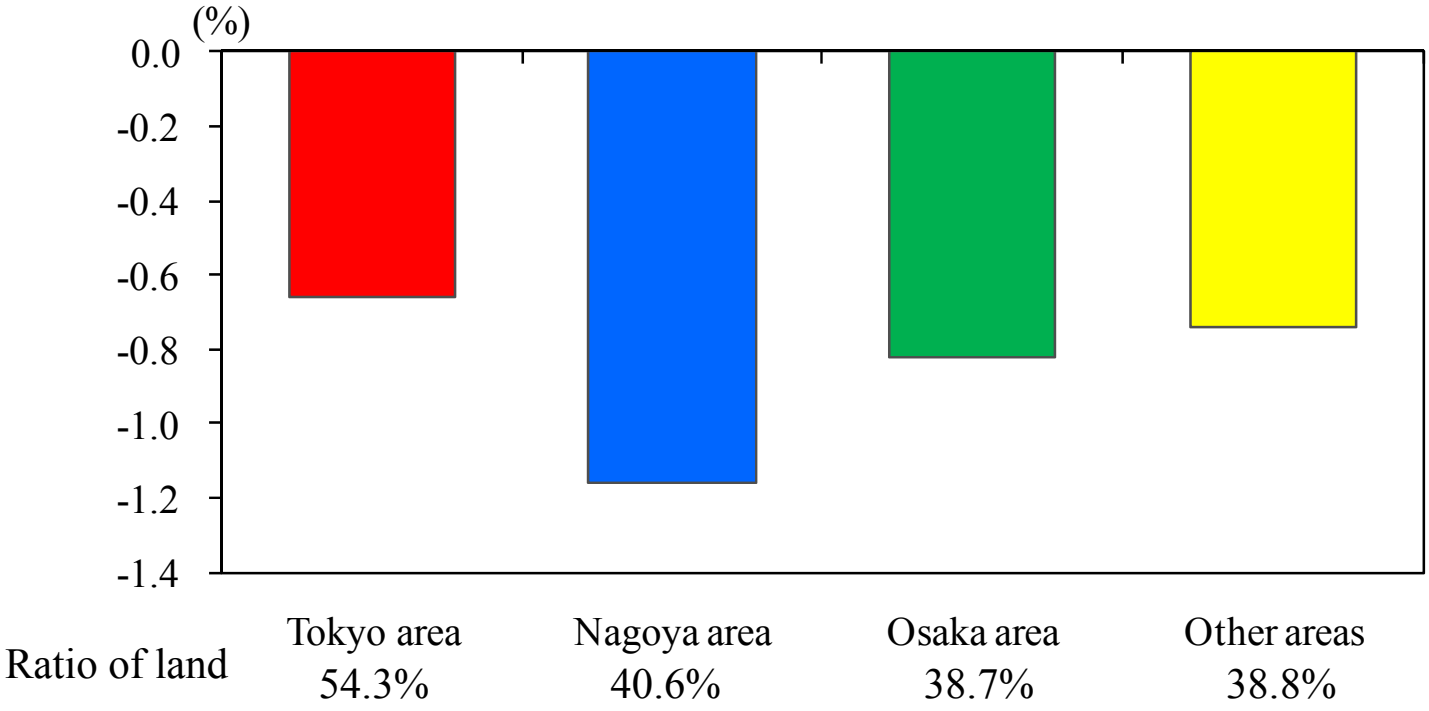
Depreciation rates for different age



5-2. Differences in depreciation rates by area

- ✓ The total depreciation rate for each area is calculated as a weighted average value of depreciation rates by area, referring to the distribution of sample offices by age.
- ✓ As shown below, the depreciation rate is small in Tokyo area with high proportion of land. As for Nagoya area, Osaka area and other areas, the rates differ because of the distribution of offices by age, although the ratio of land in each area is almost the same.

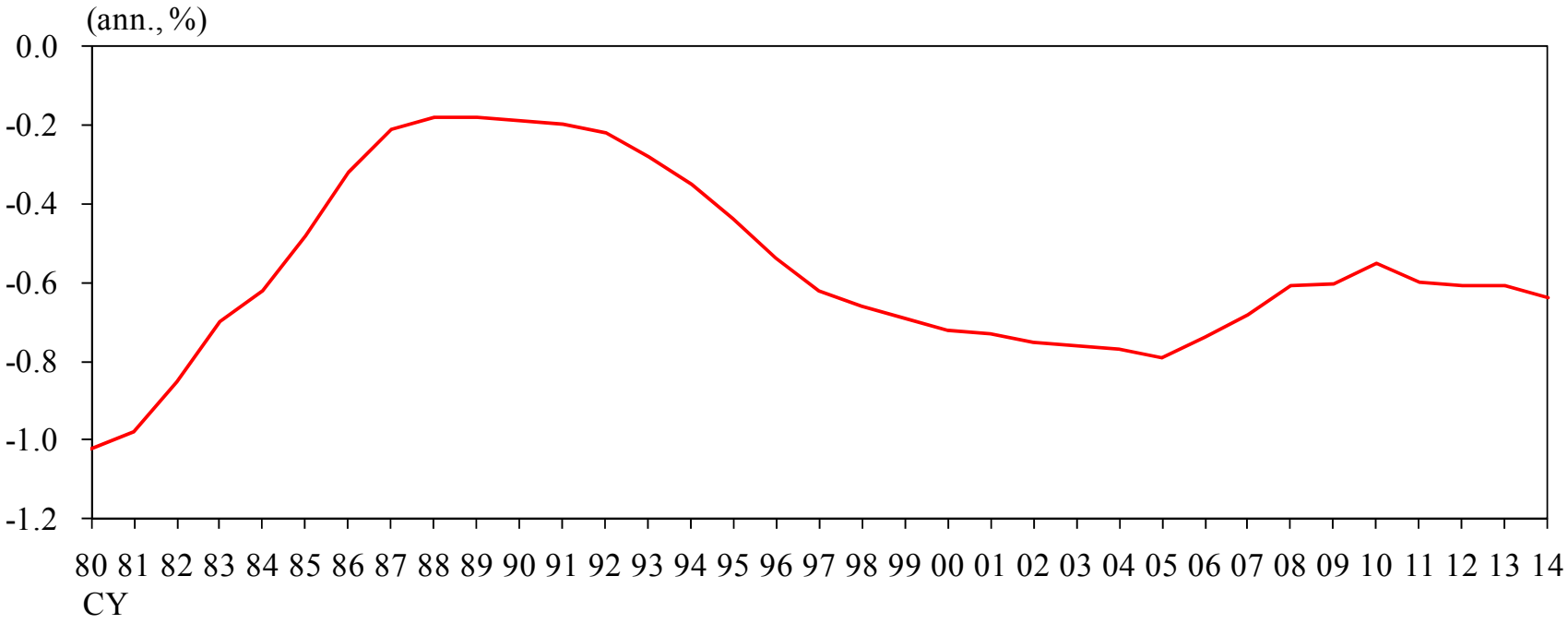
Depreciation rates for different areas



5-3. Time-series variation of depreciation rate

✓ Land prices have a great impact on depreciation rates.
When land price soaring (in the late 1980's) : decreased to 0.2% per year
When land price falling (in the mid 2000's) : increased to 0.7% per year

Example: Depreciation rate of Tokyo area

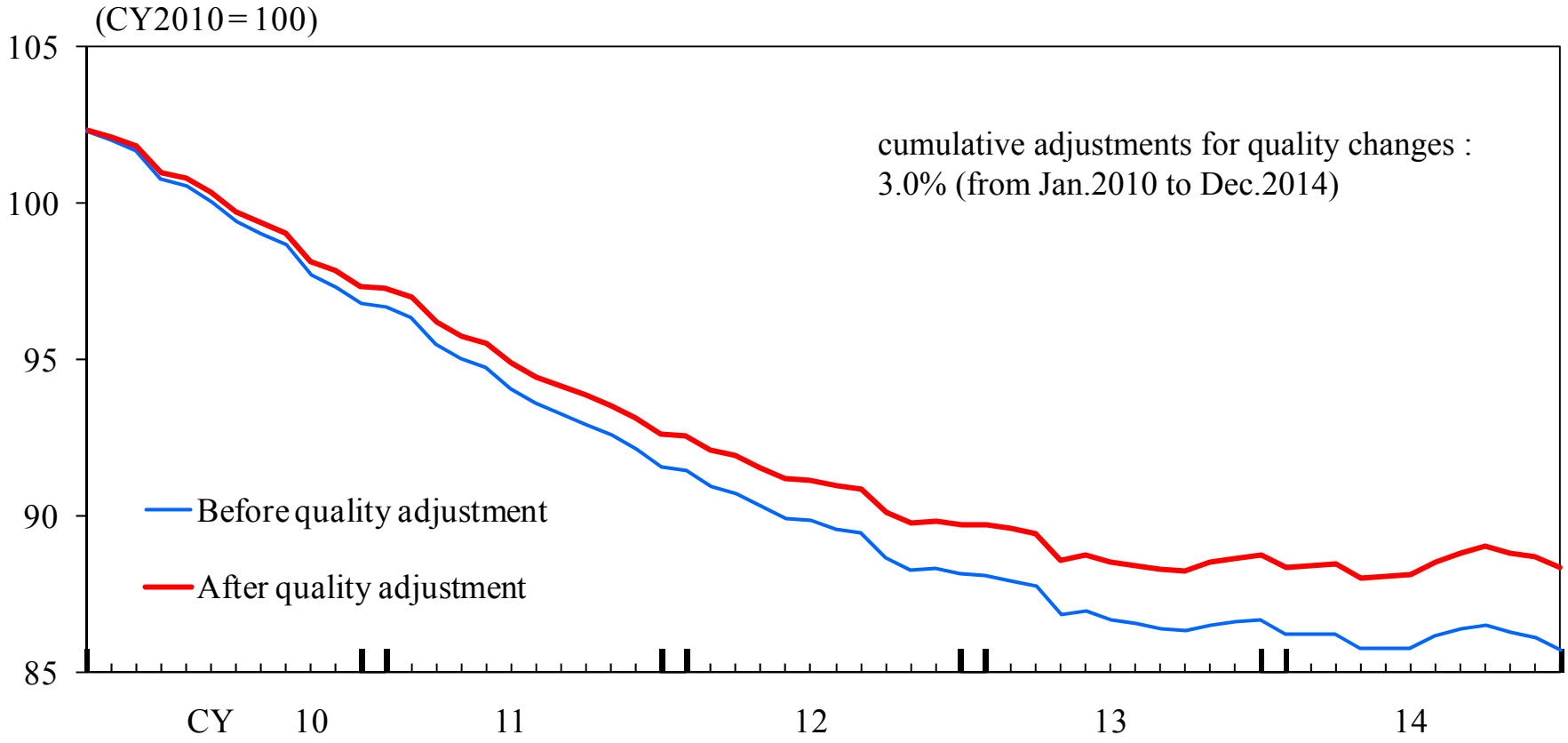


(Note) Before 2010, used the distribution of sample offices by age as of Jan. 2010.
From 2010 onward, used the distribution of sample offices by age at the timing of January of each year.

5-4. Impact on the price index due to depreciation

✓ Due to depreciation, the cumulative adjustments for quality changes amount to 3.0% over five years.

Example : Tokyo area



6. Remaining issues

- ✓ Are the depreciation rates likely to change with time?
  - —— Impact on building frame : the strengthened quake-resistance standards after the Great East Japan Earthquake.
  - —— Impact on attached equipment : advanced information technologies.
  - —— It's worth considering whether depreciation rates of other sources, such as those used in *National Accounts*, would be acceptable substitutes.
- ✓ More detailed data of patterns for renovation investment are required to enhance precision.
- ✓ The possibility of adopting the method for other Items ("Sales space rental," "Hotel rental," "Warehouse space rental," and "Parking space rental") in the Subgroup "Real estate rental."
  - —— This would require attention as to how to figure out the distribution of offices by age and average renovation patterns.

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Thanks for your attention!

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