Hitotsubashi Workshop
on Economic Measurement
October 23, 2024

Measuring Real Actual Consumption and Economic Inequalities Across Age Groups:

A New Approach Using Japanese Household Data

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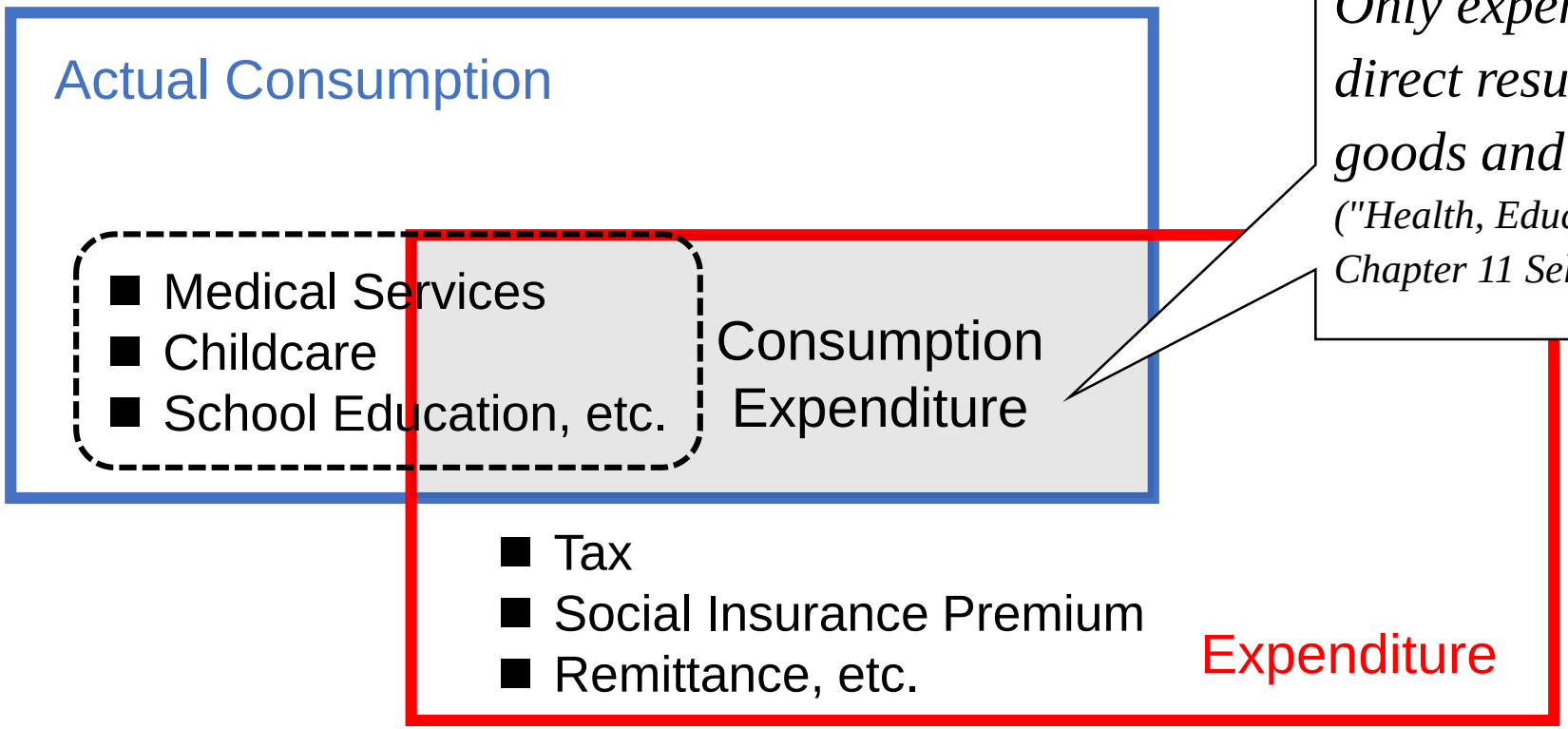
Focus of This Study



Only expenditure by households that is a direct result of purchase of individual goods and services is the scope of CPI.
("Health, Education, and Social Protection Services," Chapter 11 Selected Special Cases, p274.)

When evaluating household welfare:

(1) It is necessary to clearly define the deflator and the coverage of consumption.

(2) The conventional method, which relies on expenditure records from household surveys and official CPI, faces significant problems.

Outline

1. Starting Point of This Study:

Two Approaches in Measuring Consumption

Household Final Consumption Expenditure and Actual Consumption in SNA

2. Measurement of Actual Consumption at the Household Level

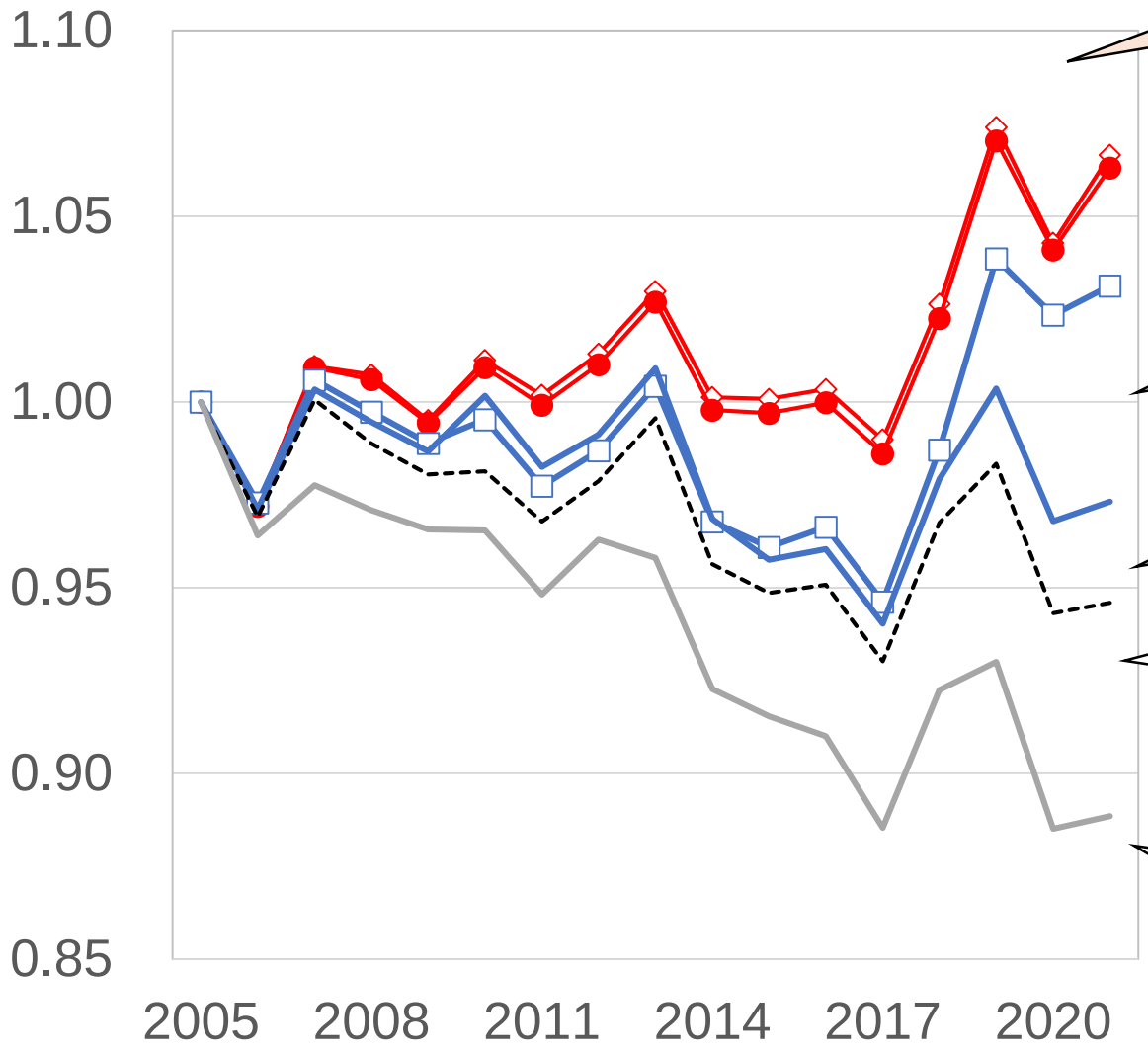
Missing Elements in Household data (imputed rent, medical services)

3. A Household Attribute-Specific Price Index: Inflation Inequality

Price Index Common to All Households vs. Attribute-specific Price Index

4. Household Real Consumption
through Attribute-Specific Price Indices and Actual Consumption

Highlight: Evaluation of Equivalent Real Consumption Using 6 Methods



Note: Households with Heads Under 40 Years Old

6. Cobb-Douglas Quantity Index

5. Including actual consumption for med

4. Deflated by
Attribute-specific Törnqvist

3. Deflated by
Common Törnqvist

2. Equivalent Household Expenditures including imputed rent for OOH deflated by the Official CPI

1. Equivalent Household Expenditures excluding imputed rent for OOH deflated by the Official CPI

1. Starting Point of This Study

Two Approaches in Measuring Consumption

(1) Who Pays (Final Expenditure)

Definition: Final consumption expenditure is the amount of expenditure on consumption goods and services (2008 SNA). Almost all the consumption data in academic papers are based on this (except for the treatment of imputed rents)

(2) Who Consumes (Actual Final Expenditure)

Definition: Actual final consumption measures the amount of consumption goods and services acquired (2008 SNA). It includes the sum of household final expenditure and in-kind expenditure by the government and non-profit organizations (NPISHs), excluding collective goods.

Origin: Originally proposed for comparing consumptions between socialist and market economies in the 1960s ("Statistics of Consumers' Expenditure in Different Systems of National Accounts and Balances, " (1963*) Conference of European Statisticians, Statistical Standards and Studies,* No.1).

CONFERENCE OF EUROPEAN STATISTICIANS

STATISTICAL STANDARDS AND STUDIES — No. 1

STATISTICS OF CONSUMERS' EXPENDITURE IN DIFFERENT SYSTEMS OF NATIONAL ACCOUNTS AND BALANCES

United Nations Statistical Commission
and Economic Commission for Europe

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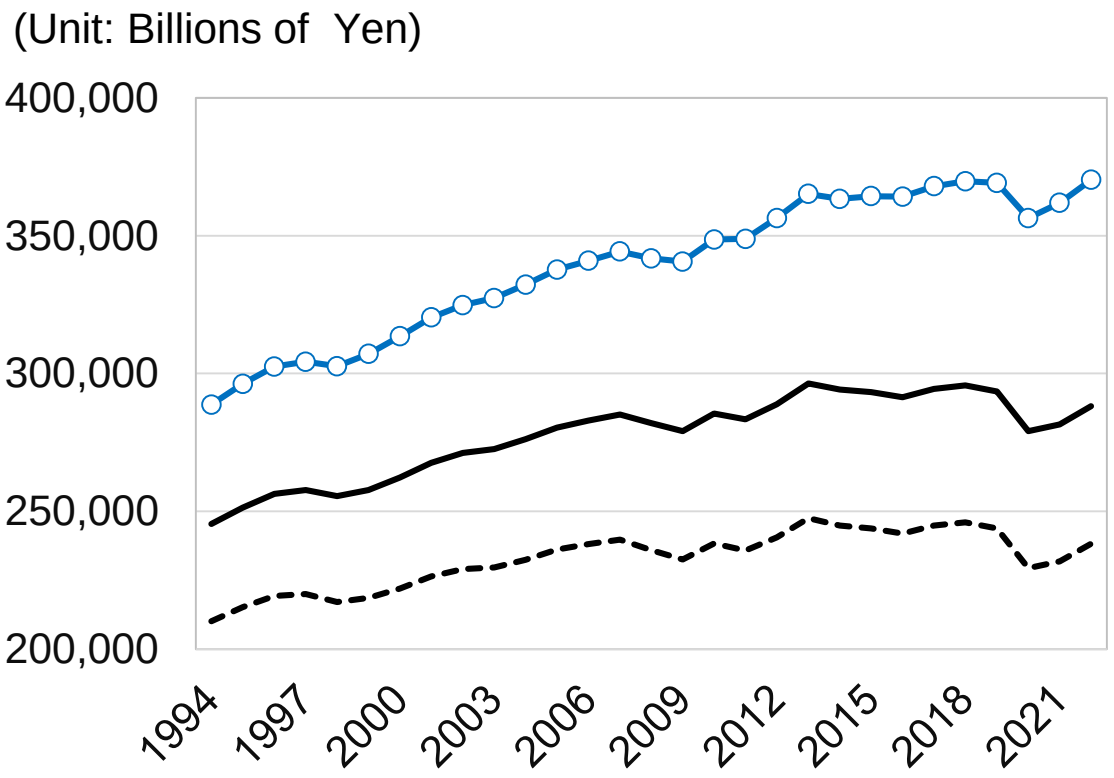
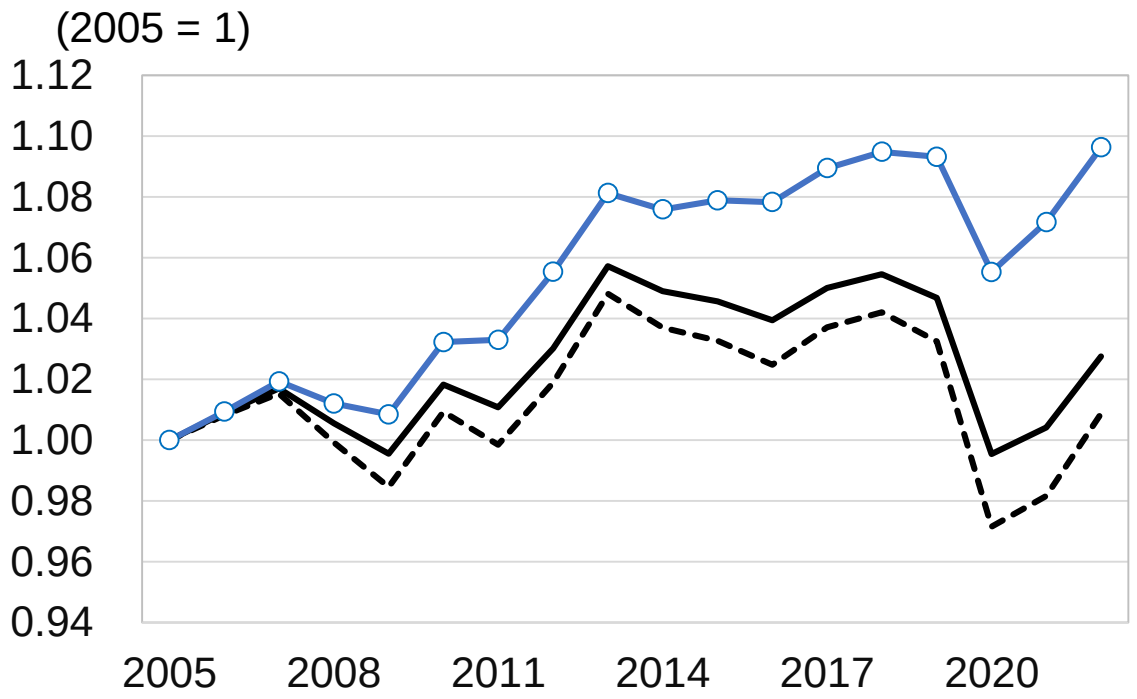
The actual final consumption of households is a measure of the value of the consumption goods and services acquired by households, whether by purchase or by transfer from government units or NPISHs, and used by households for the satisfaction of their needs (or wants). It is therefore a better indicator of their living standards than their final consumption expenditure.

SNA: Household Final Consumption, OOH, and Actual Consumption





(a) Household final consumption expenditure excluding imputed rent for owner-occupied housing

(b) Household final consumption expenditure

(c) Actual household final consumption

Data source: Compiled from "National Accounts," Cabinet Office, Government of Japan.
Note: Based on chained year 2015 prices.

2. Measurement of Actual Consumption at the Household Level:

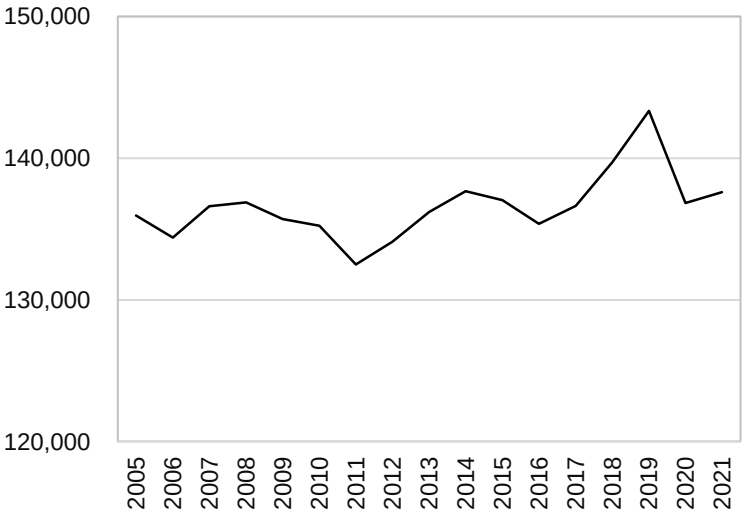
Missing Elements in Household data

Household-level Data: Family Income and Expenditure Survey (FIES)

- ✓ Utilizing microdata (# of households / month: about 8,000)
- ✓ Households with two or more members (single-member households is to be added)
- ✓ Limited to households with a head under 80 years old
- ✓ Analysis period: 2005M1-2021M12

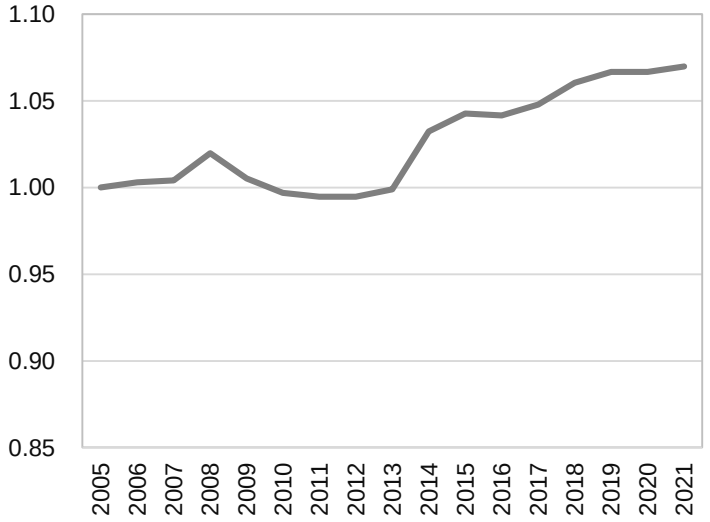
Nominal Equivalent Consumption Expenditure excl. Imputed Rent for OOH

(Unit: Yen/month)



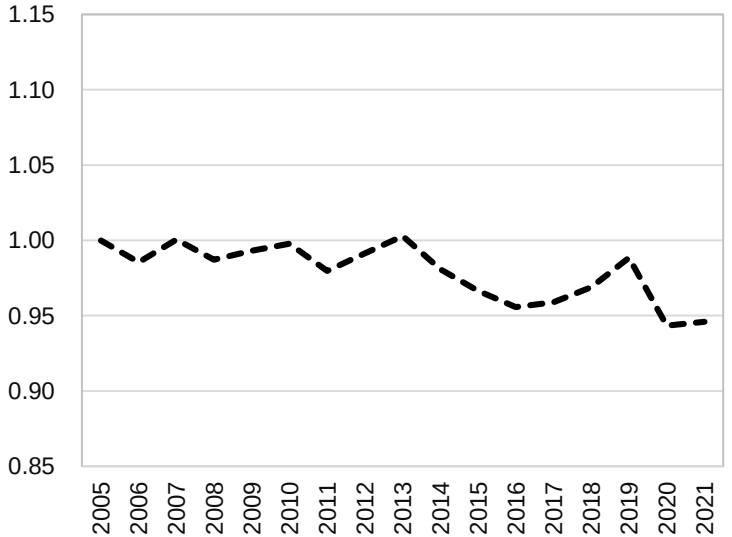
Official CPI

(Total excl. imputed rent)



(a) Real Equivalent Consumption Expenditure

(2005 = 1)



Note: Expenditures adjusted using the OECD-modified equivalence scale.
Data Source: Consumer Price Index and Family Income and Expenditure Survey conducted by the Ministry of Internal Affairs and Communications.

Household characteristics used for index calculation

Age (of the head of household)
under 40
40-49
50-59
60-69
70-79

Household income
I
II
III
IV

Region
Hokkaido & Tohoku
Kanto
Hokuriku
Tokai
Kinki
Chugoku
Shikoku
Kyusyu & Okinawa

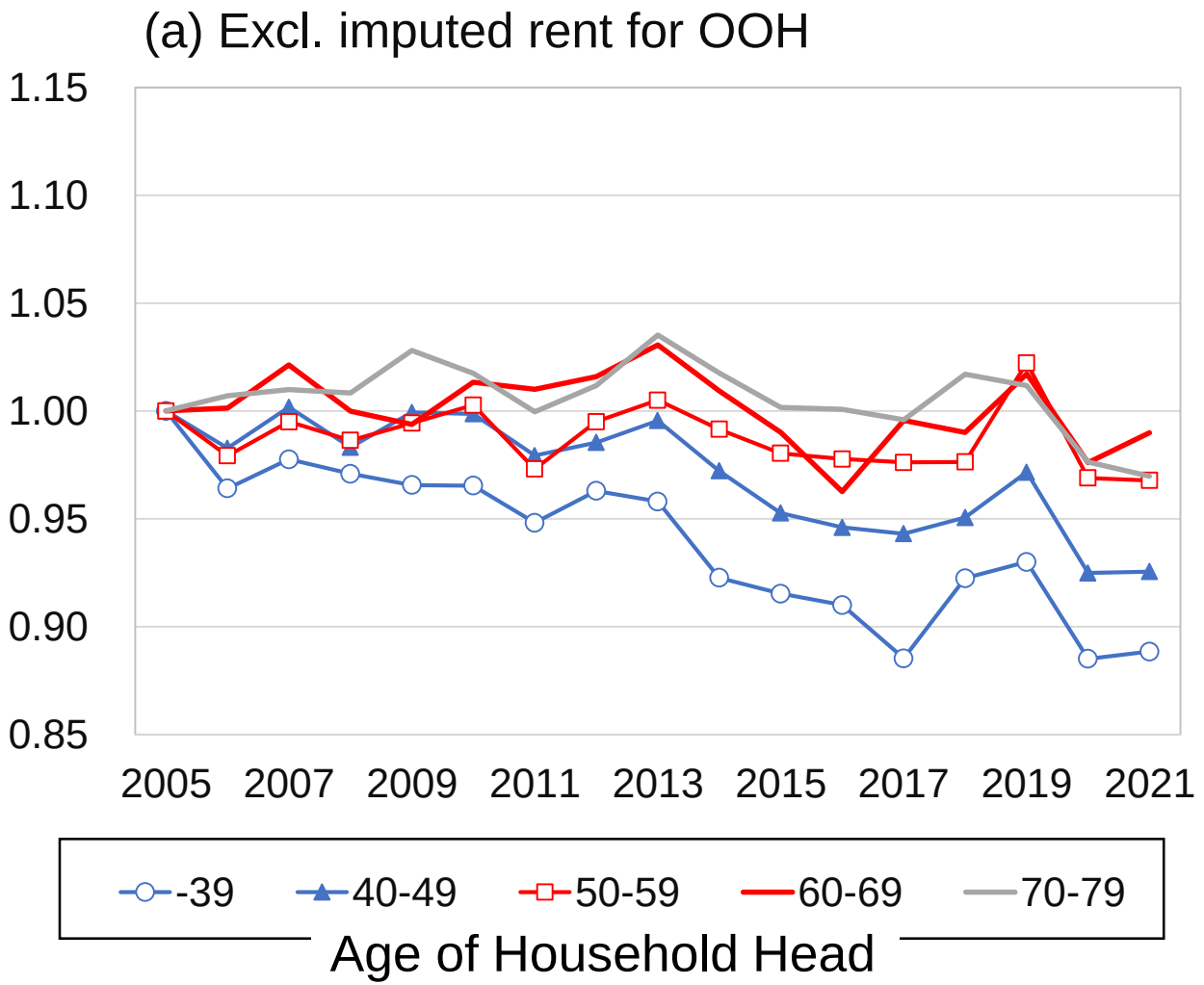
Eight Regions

Region
Hokkaido & Tohoku
Kanto
Hokuriku
Tokai
Kinki
Chugoku
Shikoku
Kyusyu & Okinawa

Real Equivalent Consumption Expenditures by Age Category (2005 = 1)

- Decline in Real Household Consumption Expenditure in Japan
- Notable Decreases Among Young and Middle-Aged Groups

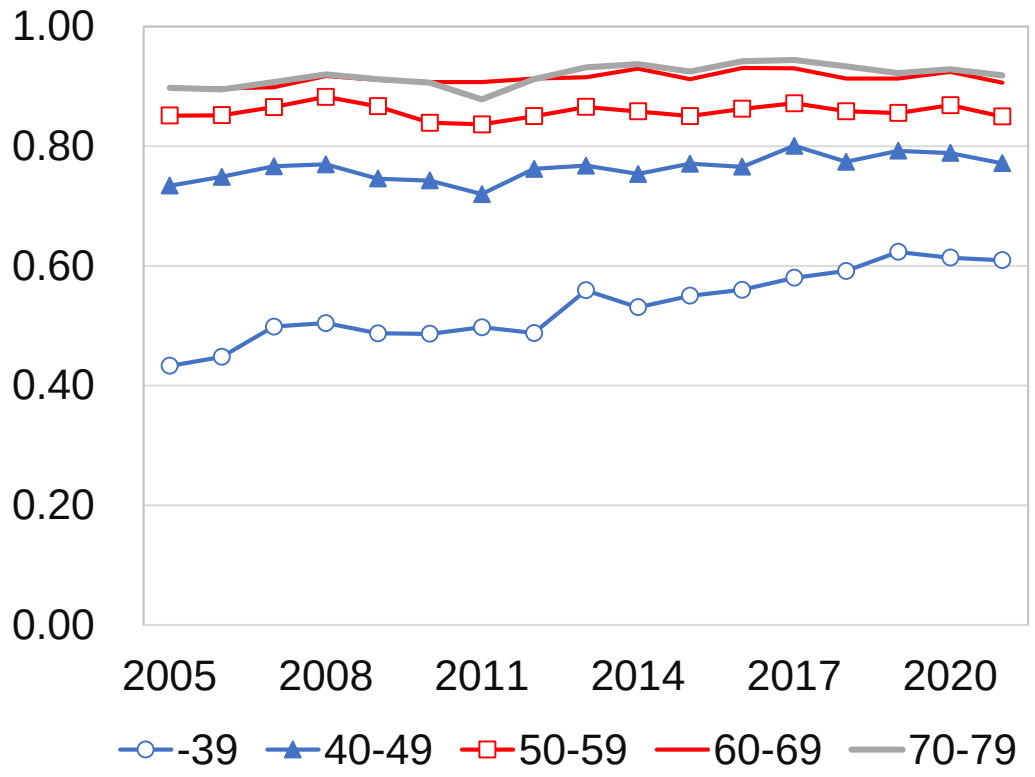
  Vihriälä (2017), **Murata & Hori (2023)**
- The Japanese government's cabinet meeting in 2019 resolved to enhance economic support for young people.



Note: Expenditures adjusted using the OECD-modified equivalence scale.
Data Source: Consumer Price Index and Family Income and Expenditure Survey conducted by the Ministry of Internal Affairs and Communications.

Missing Element 1: Imputed Rent for OOH

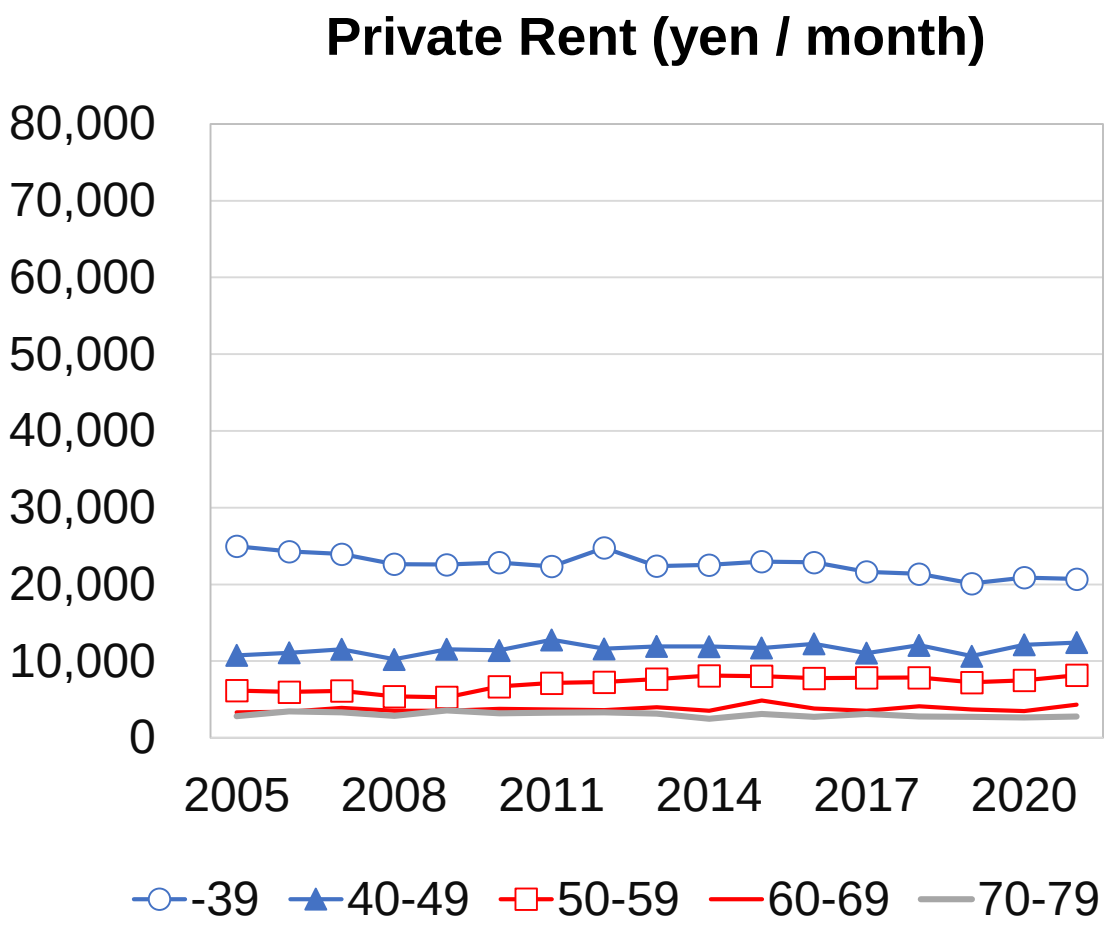
Trends in Homeownership Rates by Age Category

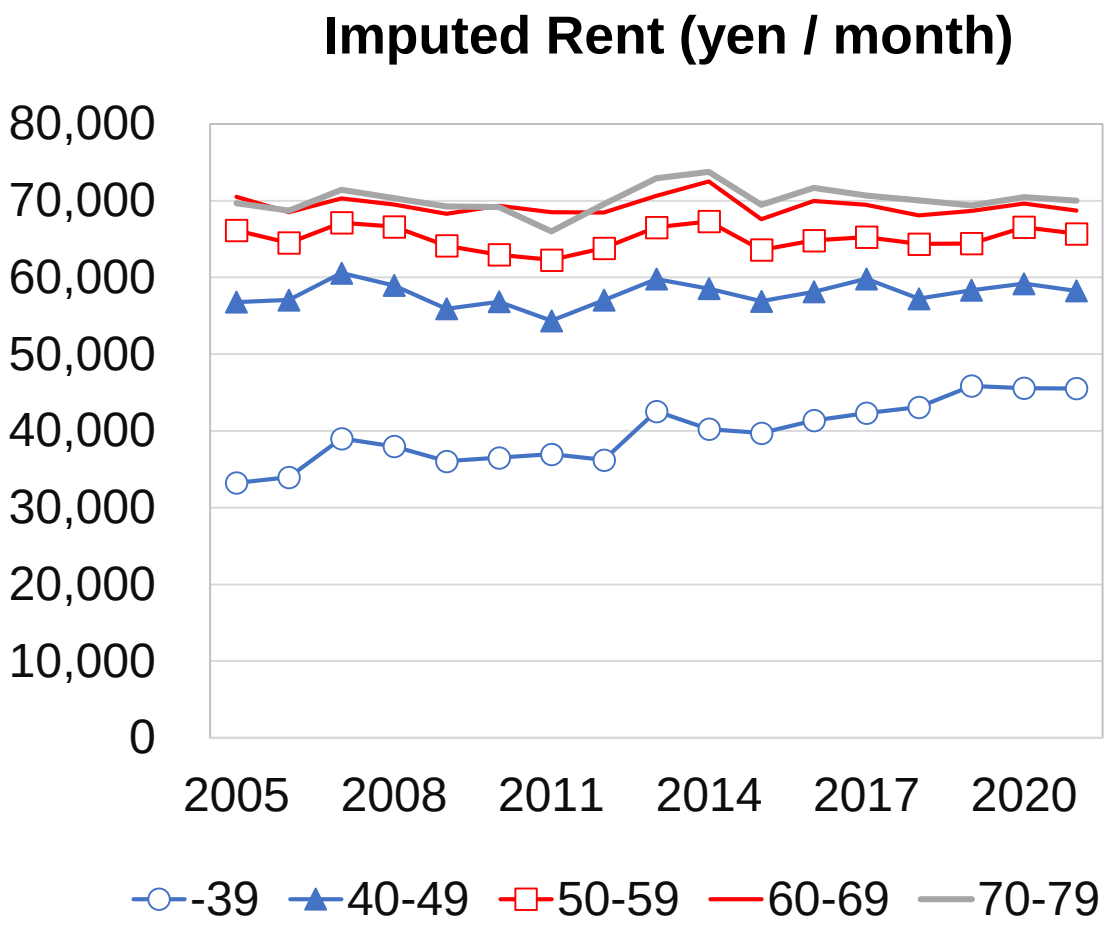


Data Source: Family Income and Expenditure Survey conducted by the Ministry of Internal Affairs and Communications.

- The mortgage tax deduction in Japan allows individuals to deduct a portion of their income tax.
- Strong support for families with children.

Average Monthly Value:
Private Rent vs. Imputed Rent for OOH





Data Source: Family Income and Expenditure Survey conducted by the Ministry of Internal Affairs and Communications.
Note: Including households with zero expenditure.

Missing Element 2: Actual Consumption for Medical Services

Health care costs for Households

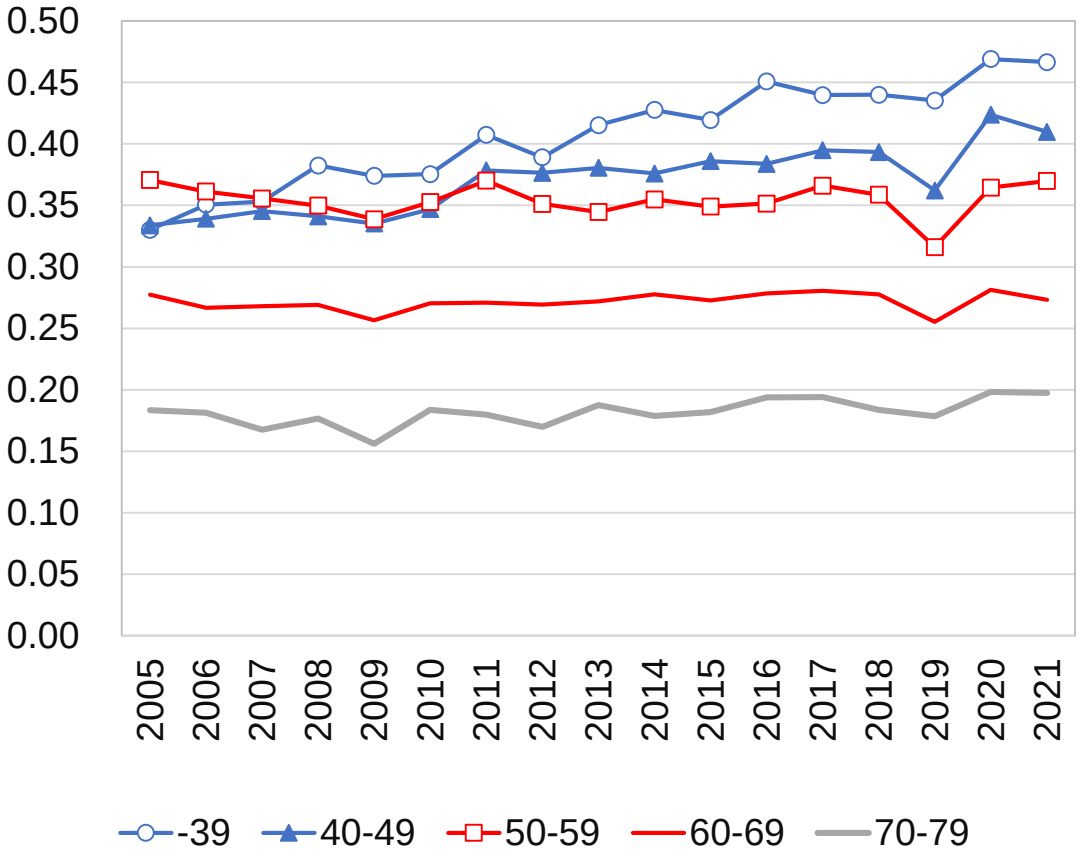
Japan adopts National Health Insurance System. The national standard for the self-payment ratio of medical services is 30%. For elderly over 75, it is 20%.

An increasing number of municipalities are introducing their own financial support systems for children. In Tokyo’s 23 wards, medical expenses became free for junior high school students (15 years old) in 2008, and in 2023, this was extended to high school students (18 years old).

Although other regions may not provide the same level of support, subsidies for children's medical expenses have been expanding, significantly reducing the financial burden on families for their children's healthcare costs.

Missing Element 2: Actual Consumption for Medical Services

Rate of Households with Zero Healthcare Expenditures in FIES

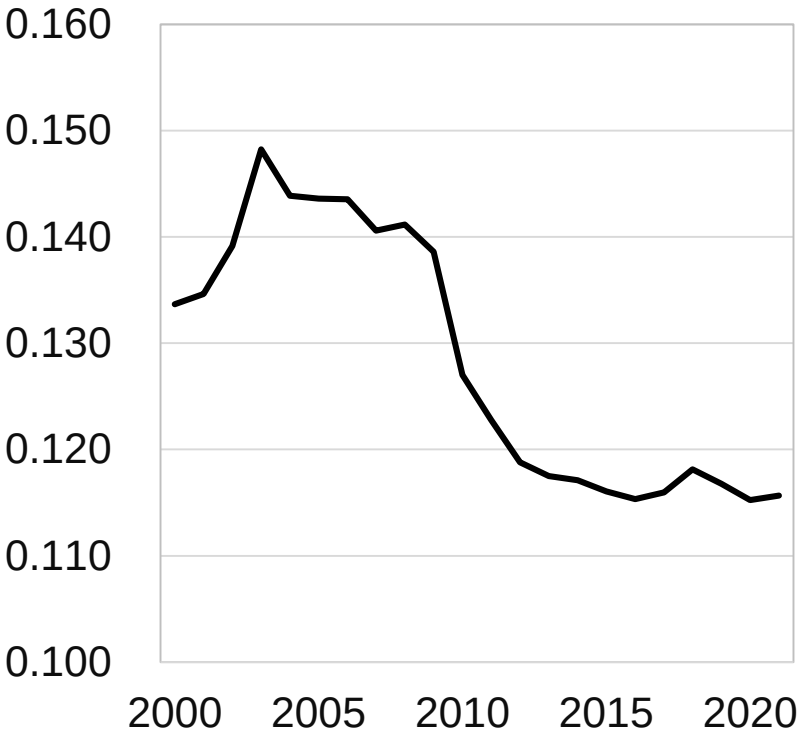


- In Japan, municipalities offer comprehensive support to reduce children's medical cost.

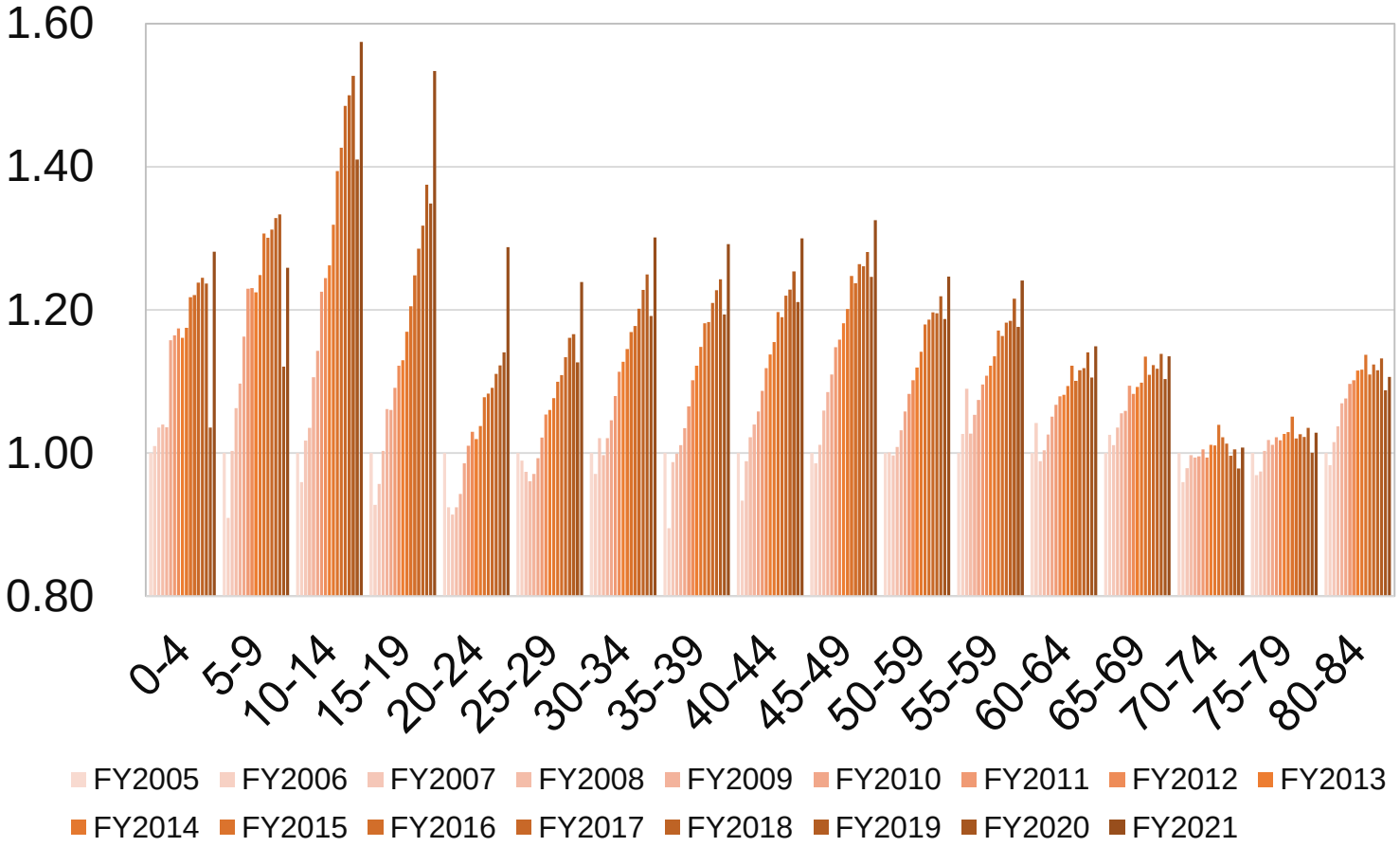
Data Source: Family Income and Expenditure Survey conducted by the Ministry of Internal Affairs and Communications.

Actual Consumption for Medical Services

Share of Medical Expenses Borne by Patients



National Health Care Expenditures by Age Category (Per Capita, Nominal Values, Year 2005=1)



Data source: Ministry of Health, Labour and Welfare, “Estimates of National Medical Care Expenditure”.

Data Source: Household Consumption Expenditure

Variable	Data source	Note
(a) Expenditure by Item	Family Income and Expenditure Survey (**FIES**)	✓ utilizing microdata (# of households / month: about 8,000) ✓ households with two or more members (single-member households is to be added) ✓ limited to households with a head under 80 years old ✓ analysis period: 2005M1-2021M12
(b) Imputed Rent for OOH		✓ Estimate the rent function based on home-ownership, residential area, rent amount, and floor space
(c) Actual Consumption for Medical Services	Estimates of National Medical Care Expenditure (国民医療費)	✓ Nominal medical expenses per capita by age group are published ✓ Match the above medical expenses to households based on the age information of household members

3. A Household Attribute-Specific Price Index:

Inflation inequality

Jaravel (2019, *QJE*) , **Wimer & Collyer & Jaravel** (2019*, Policy Brief, Columbia Univ.)*

When using price indices by income-brackets, (compared to using the ordinal CPI)

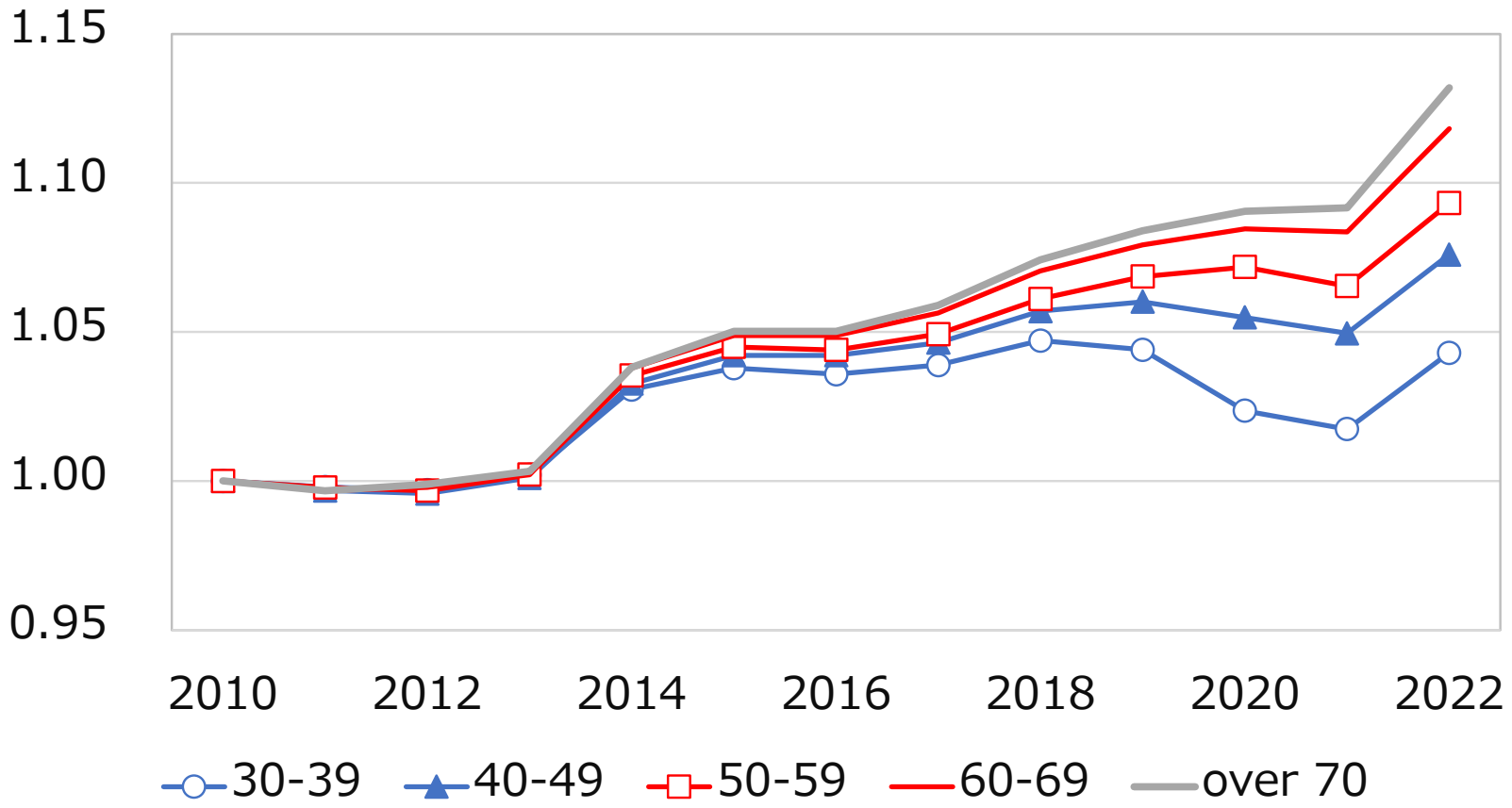
an additional 3.2 million individuals fall below the poverty line.

Moretti (2013, *Applied Econ*.)

Estimating CPI taking into account differences in housing prices by city

-> Nominal wage premium for college graduates (+20% in 2000) declined to +14%

Official CPI by Age Category



Data source: Created from the Ministry of Internal Affairs and Communications' "Consumer Price Index"
Note: Total excluding owner-occupied imputed rent.

Estimation of Real Actual Consumptions

1. When the CPI reflects changes in government expenditures

With the introduction of free kindergarten and daycare for children aged three and above, the amount of expenditure has significantly decreased, and the corresponding CPI has also decreased. Then, the impact of such policies can be captured by attribute specific price indices.

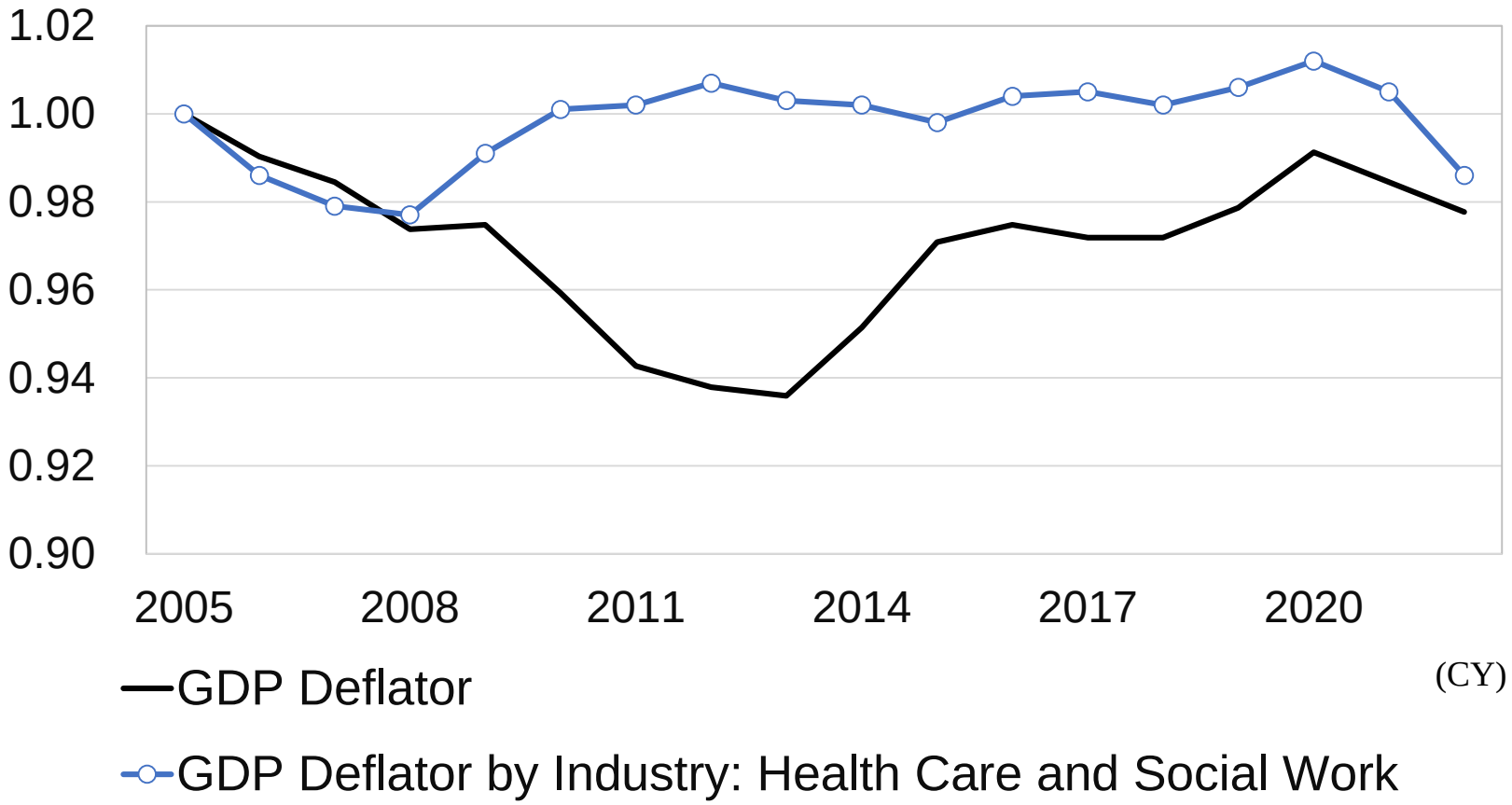
2. When prices are different across households

Medical expenses for children up to junior high school are free in Japan. Additionally, the proportion of medical expenses covered by insurance varies by age. In the official price data, prices are assumed to be identical across households (the law of one price). Consequently, attribute-specific CPI fails to capture these differences. Furthermore, when prices are set to zero, it becomes impossible to capture consumption based on expenditure data.

Data Source: Household Consumption Expenditure

Variable	Data source	**Price Information**
(a) Expenditure by Item	Family Income and Expenditure Survey (**FIES**)	✓ by item (# of items: 500) ✓ national average (prefecture-specific itemized CPI is not publicly available) ✓ Prices are assumed to be the same for all households, with only expenditure weights differing.
(b) Imputed Rent for OOH		
(c) Actual Consumption for Medical Services	Estimates of National Medical Care Expenditure (国民医療費)	$P_t^{SNA,M}$: GDP deflator for medical services

GDP Deflator



Data source: Compiled from "National Accounts," Cabinet Office, Government of Japan.

Coverage of Consumption Items for Price Index Estimation

	Coverage	Price Information
(a)	Items in FIES	Official CPI
(b)	(a) + imputed rent for OOH	
(c)	(b) + actual consumption for medical services	GDP deflator for medical services

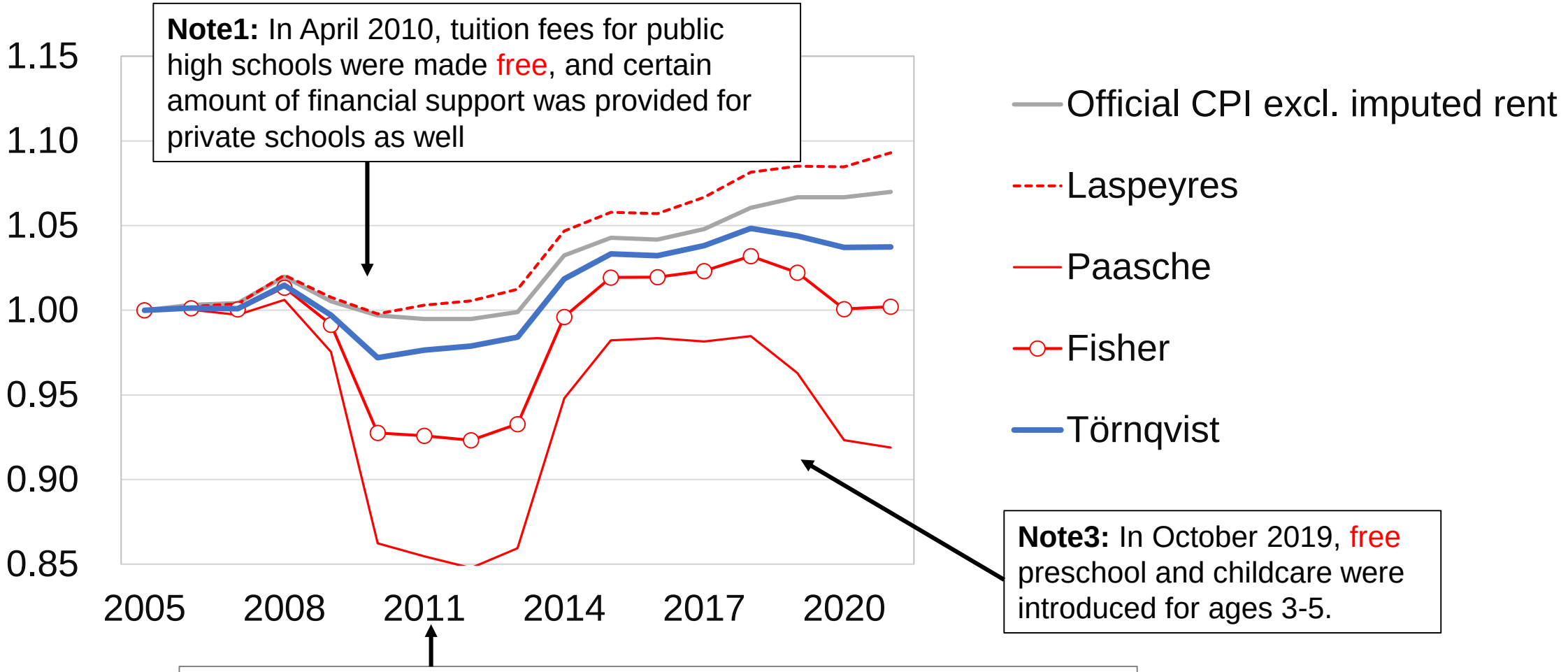
Combination of Methods for Estimating Price Index

	Coverage
(a)	Items in FIES
(b)	(a) + imputed rent for OOH
(c)	(b) + actual consumption for medical services

Index Formula

- Laspeyres
- Paasche
- Fisher
- Törnqvist

Price Indices excl. imputed rent for OOH



Note1: In April 2010, tuition fees for public high schools were made free, and certain amount of financial support was provided for private schools as well

Note2: In July 2011, Japanese TV sets switched to digital broadcasting, and conventional TV sets could no longer receive the signals. Therefore, many households purchased new TV sets compatible with digital broadcasting around 2011.

Note3: In October 2019, free preschool and childcare were introduced for ages 3-5.

Note: Except for the Official CPI, the figures are our estimates based on information from the elementary level CPI and the FIES.

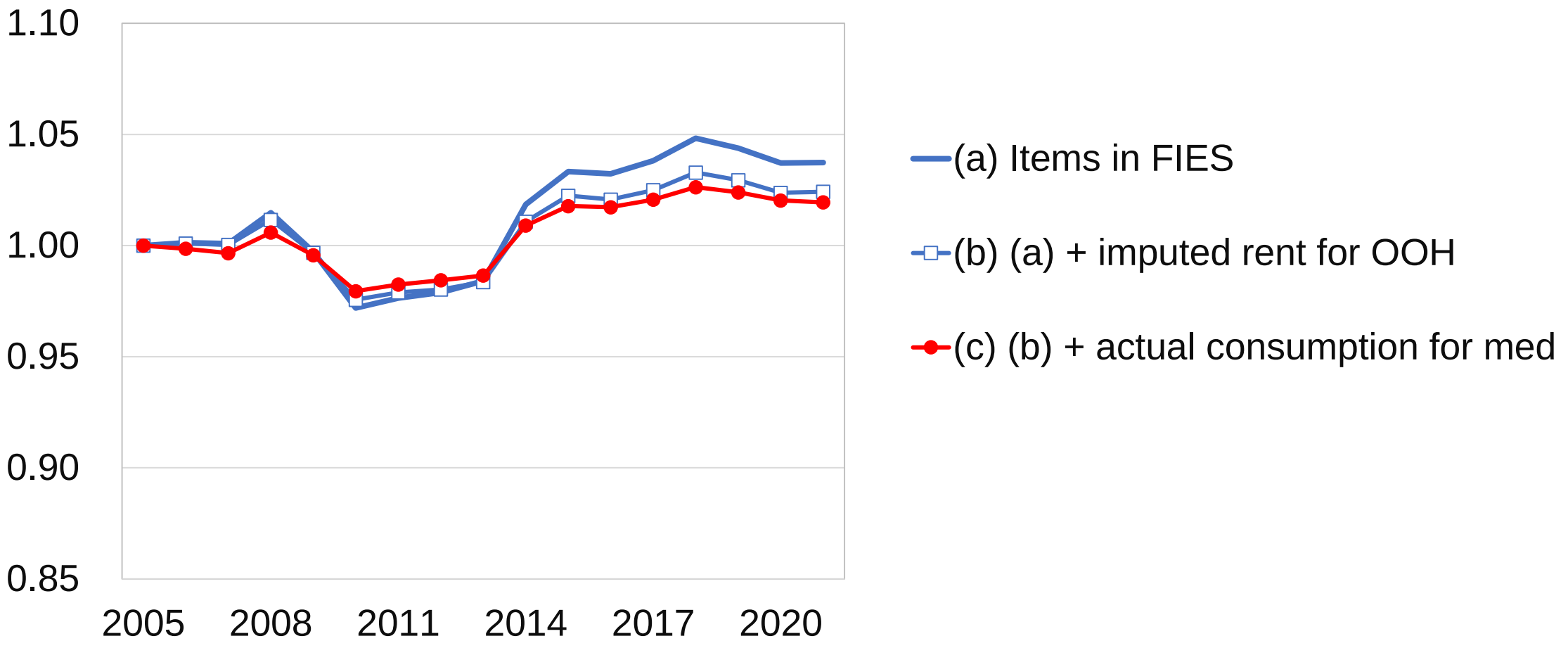
Combination of Methods for Estimating Price Index

	Coverage
(a)	Items in FIES
(b)	(a) + imputed rent for OOH
(c)	(b) + actual consumption for medical services

Index Formula

- Laspeyres
- Paasche
- Fisher
- Törnqvist

Price Indices: Törnqvist



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Combination of Methods for Estimating Price Index

	Coverage
(a)	Items in FIES
(b)	(a) + imputed rent for OOH
(c)	(b) + actual consumption for medical services

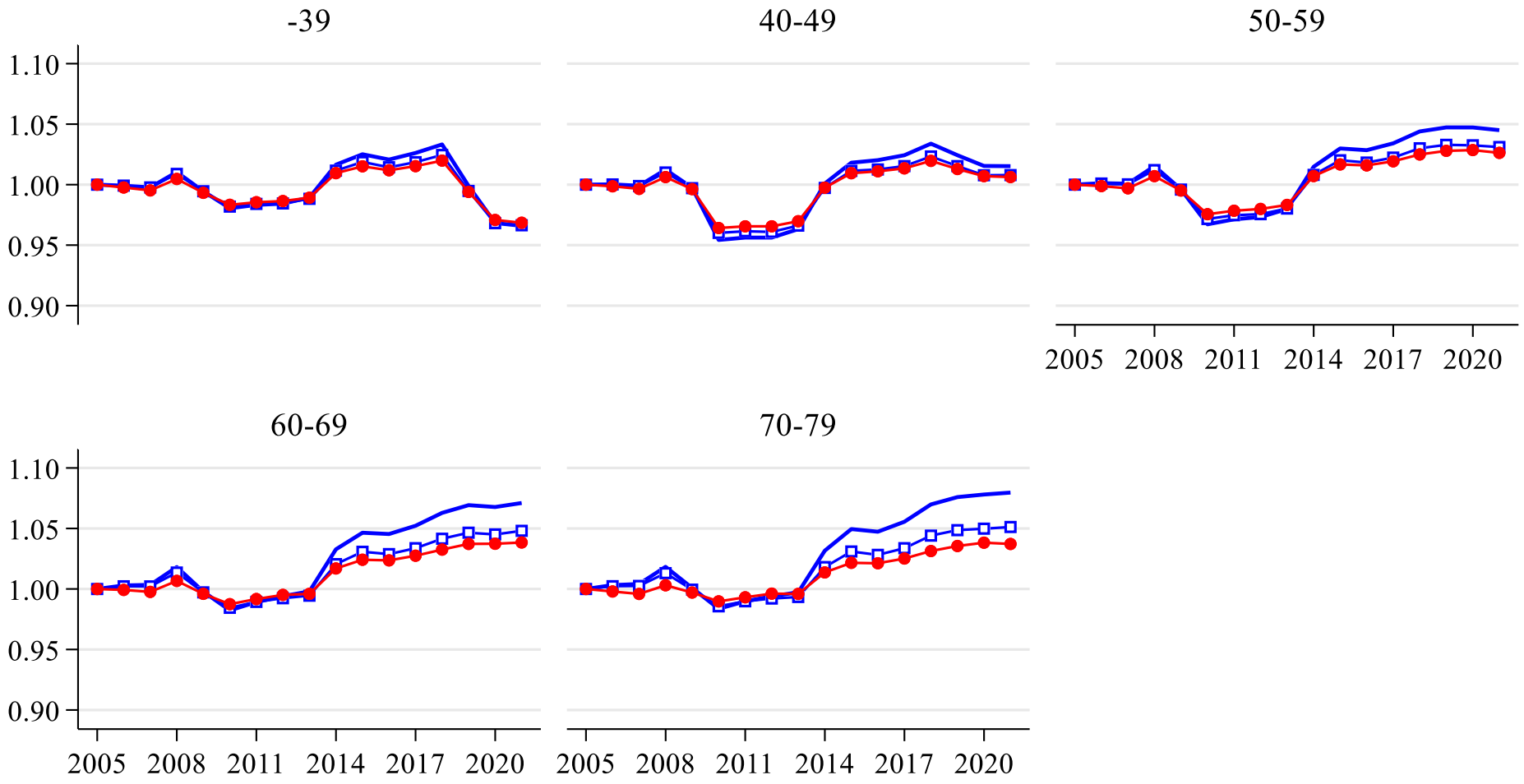
Index Formula

- Laspeyres
- Paasche
- Fisher
- Törnqvist

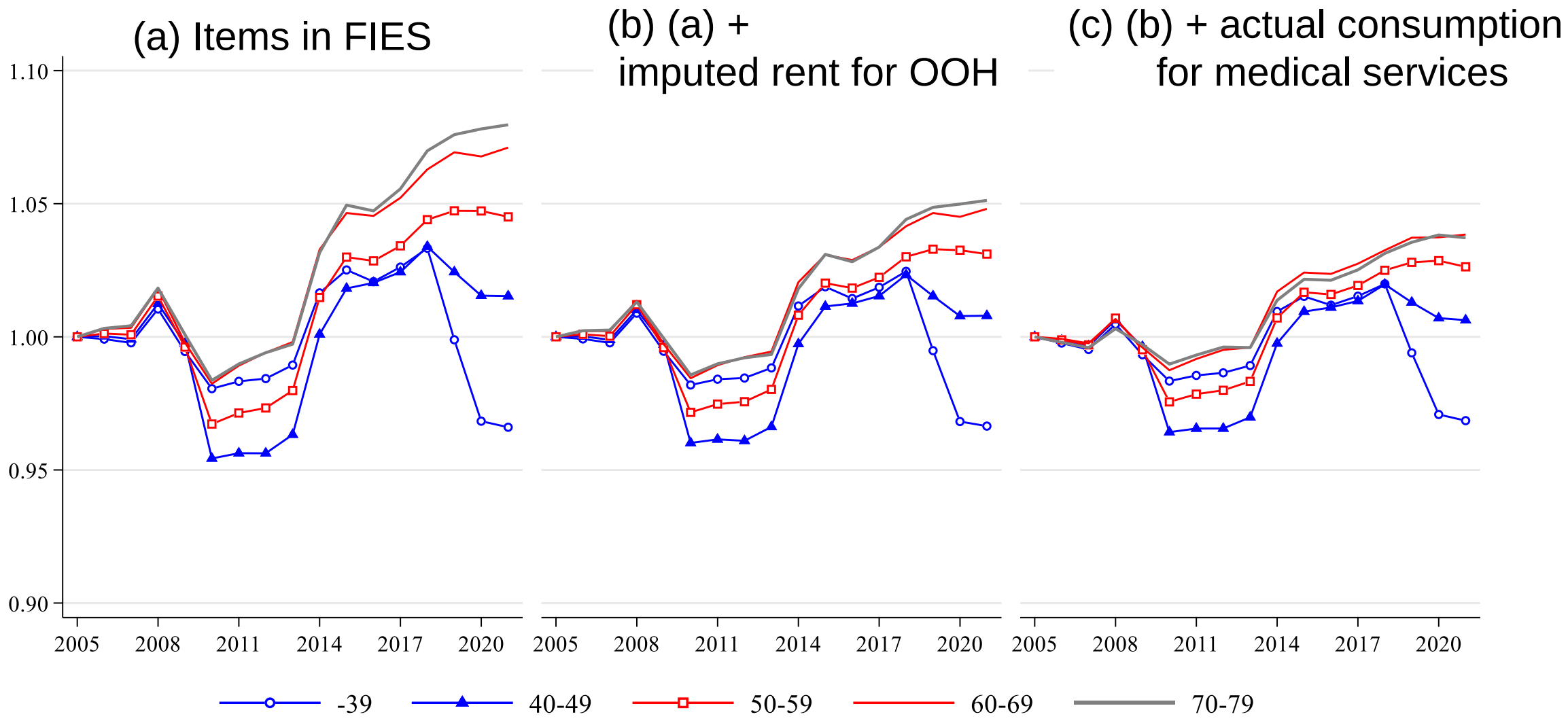
Inflation Inequality

- Common to Household Attributes
- Attribute-specific

Attribute-specific Price Indices: by Age × Item Coverage



Attribute-specific Price Indices: by Item Coverage × Age



4. Household Real Consumption through Attribute-Specific Price Indices and Actual Consumption

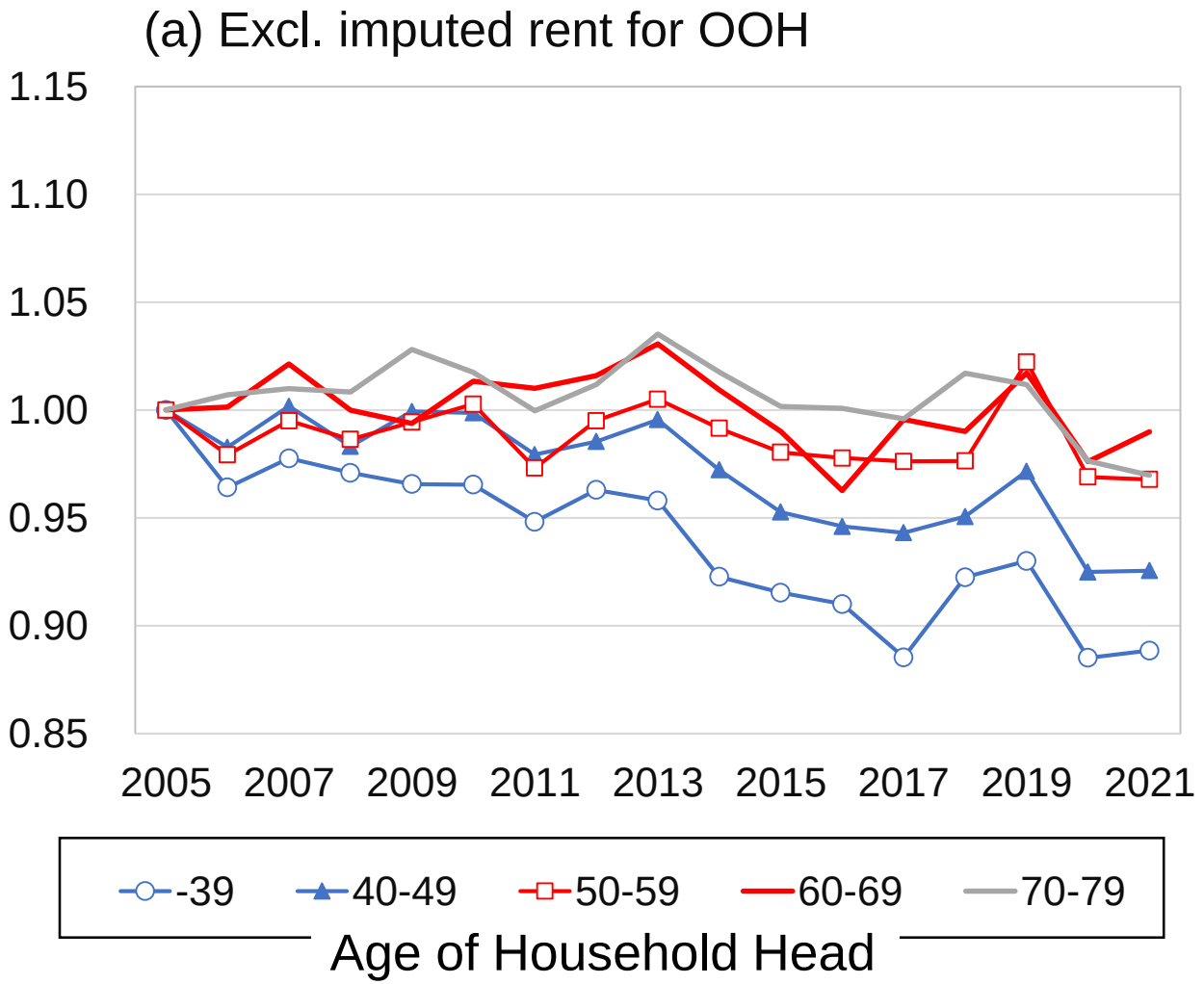
6 Methods for Calculating Real Consumption Expenditure

No.	Imputed rent	Actual consumption for medical services	Price index for deflation
1	✕	✕	Official CPI excl. imputed rent
2			
3			
4			
5			
6			

Real Equivalent Consumption Expenditures by Age Category (2005 = 1)

- Decline in Real Household Consumption Expenditure in Japan
- Notable Decreases Among Young and Middle-Aged Groups

  Vihriälä (2017), **Murata & Hori (2023)**
- The Japanese government's cabinet meeting in 2019 resolved to enhance economic support for young people.



Note: Expenditures adjusted using the OECD-modified equivalence scale.
Data Source: Consumer Price Index and Family Income and Expenditure Survey conducted by the Ministry of Internal Affairs and Communications.

6 Methods for Calculating Real Consumption Expenditure

No.	Imputed rent	Actual consumption for medical services	Price index for deflation
1	✗	✗	Official CPI excl. imputed rent
2	✓	✗	Official CPI
3	✓	✗	Common Törnqvist
4	✓	✗	Attribute-specific Törnqvist
5	✓	✓	Attribute-specific Törnqvist
6	✓	✓	Cobb-Douglas Quantity Index

Quantity Indices for Medical Services

When incorporating the medical services, there are two options.

1. Using Törnqvist index

The estimated household medical expenses, calculated from national medical expenditures, are incorporated into the total expenditures of each household, with the health care deflator from SNA used as the price, and the real values are calculated using the Törnqvist index. In other words, medical expenses are treated in the same way as ordinary consumption expenditures. While this method is convenient, there is a possibility that, with regard to medical expenses, the cost minimization problem may not be at an interior solution (because actual price is zero for children). If this is the case, the method may be inconsistent with the superlative index

Quantity Indices for Medical Services

2. When prices are different across households

Assume that the utility derived from healthcare services is multiplicatively separable and takes a Cobb-Douglas form with the utility derived from non-medical goods. Under this assumption, the household's optimization problem becomes independent. The coefficients of the Cobb-Douglas utility function can be derived from the expenditure share of national medical expenses in total expenditures for each generation. Although this imposes a strong assumption on the functional form, we do not need to assume interior solution for the healthcare services.

Quantity Indices for Medical Services

$$QI_{i,t}^{M} = \left(\frac{C_{i,t}^{M}}{C_{i,s}^{M}}\right) \Big/ \left(\frac{P_{t}^{SNA,M}}{P_{s}^{SNA,M}}\right)$$

Actual Medical Consumption: Estimated from National Medical Care Expenditure and FIES Microdata

$C_{i,t}^{M}$	Nominal Equivalent Actual Medical Consumption

Price Indices: Published Data

$P_{t}^{SNA,M}$	GDP deflator for Health and Social Services published in SNA

Aggregate Quantity Index: Cobb-Douglas Type Composite Index

$$QI_{i,t}^{4} = \left[QI_{i,t}^{M}\right]^{\alpha_i}\left[QI_{i,t}^{O}\right]^{(1-\alpha_i)}, \text{ where } QI_{i,t}^{M} = \left(\frac{C_{i,t}^{M}}{C_{i,s}^{M}}\right) \Big/ \left(\frac{P_{t}^{SNA,M}}{P_{s}^{SNA,M}}\right).$$

$\boldsymbol{\alpha_i}$: Represents the weights of actual medical consumption and real non-medical consumption in the quantity index calculation.

Price Indices: Published Data and Our Estimates

$P_{i,t}^{Tor,O}$	The Törnqvist index of household i at time t, excluding, medical, and health care.

Expenditure in FIES

$E_{i,t}^{O}$	Equivalent nominal expenditure of household *i* at time *t,* excluding, medical, and health care.

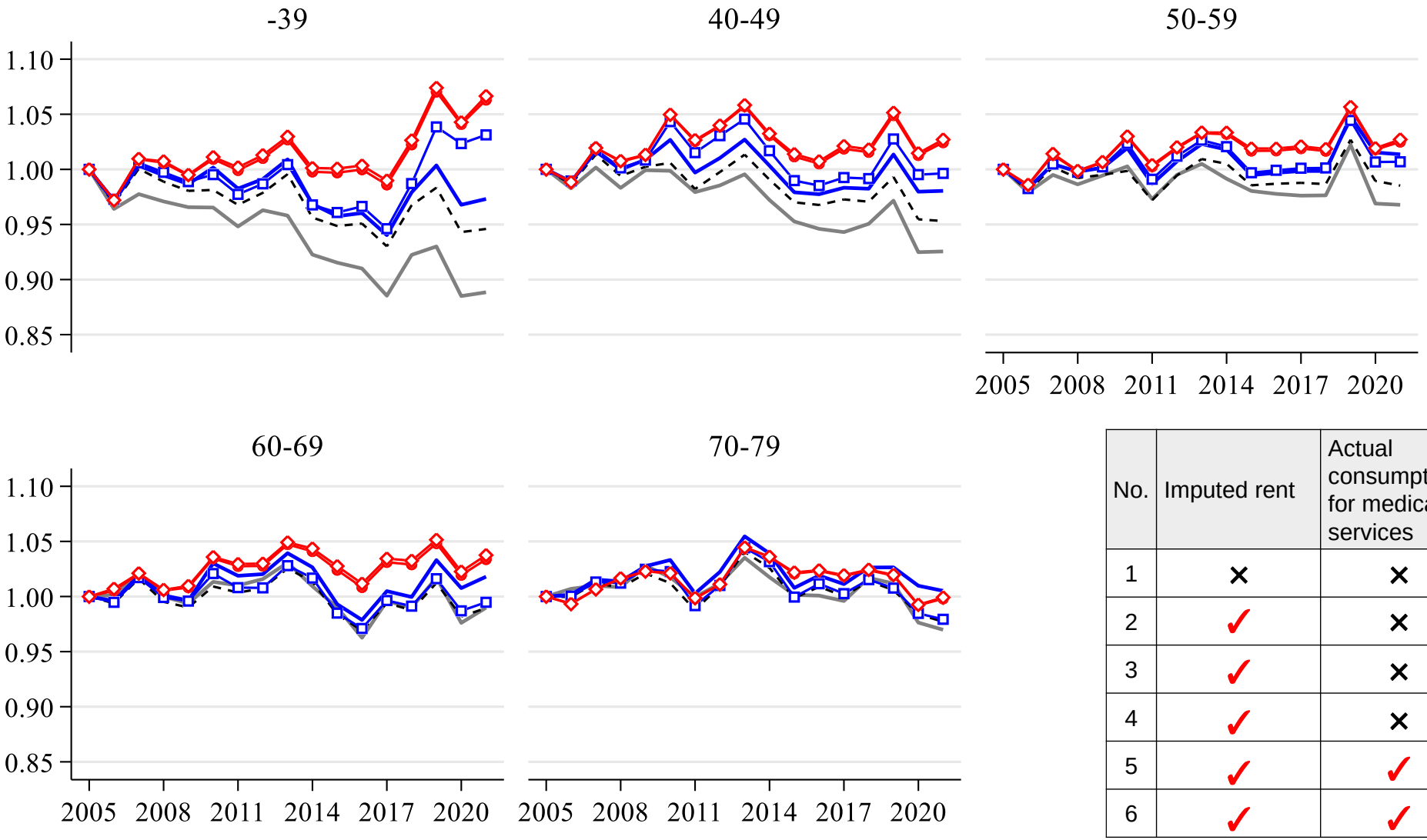
$$QI_{i,t}^{O} = \frac{E_{i,t}^{O}}{E_{i,s}^{O}} \Big/ \frac{P_{i,t}^{Tor}}{P_{i,s}^{Tor}}$$

Estimated Value of α_i

year	Calculation from SNA		Estimates based on FIES						
	excl. imputed rent for OOH	incl. imputed rent	excl. imputed rent	incl. imputed rent					
					-39	40-49	50-59	60-69	70-79
2005	0.130	0.112	0.227	0.184	0.134	0.127	0.162	0.214	0.307
2006	0.130	0.112	0.227	0.184	0.132	0.124	0.163	0.220	0.300
2007	0.132	0.114	0.230	0.185	0.131	0.125	0.167	0.213	0.300
2008	0.137	0.117	0.229	0.185	0.135	0.127	0.160	0.210	0.304
2009	0.144	0.123	0.233	0.189	0.135	0.128	0.165	0.219	0.303
2010	0.148	0.127	0.239	0.195	0.144	0.132	0.170	0.221	0.305
2011	0.151	0.129	0.247	0.201	0.147	0.137	0.174	0.227	0.312
2012	0.152	0.130	0.249	0.202	0.149	0.135	0.171	0.228	0.307
2013	0.150	0.130	0.250	0.202	0.149	0.138	0.168	0.224	0.305
2014	0.153	0.132	0.253	0.204	0.153	0.136	0.170	0.225	0.303
2015	0.157	0.135	0.259	0.211	0.156	0.141	0.174	0.234	0.311
2016	0.156	0.135	0.260	0.210	0.155	0.141	0.175	0.233	0.306
2017	0.156	0.136	0.262	0.213	0.162	0.144	0.174	0.231	0.309
2018	0.156	0.136	0.256	0.208	0.158	0.143	0.170	0.231	0.301
2019	0.160	0.139	0.254	0.207	0.157	0.142	0.166	0.227	0.303
2020	0.168	0.145	0.254	0.205	0.145	0.138	0.165	0.227	0.299
2021	0.174	0.151	0.264	0.214	0.162	0.149	0.173	0.231	0.307
Average	**0.150**	**0.130**	**0.247**	**0.200**	**0.147**	**0.136**	**0.169**	**0.224**	**0.305**

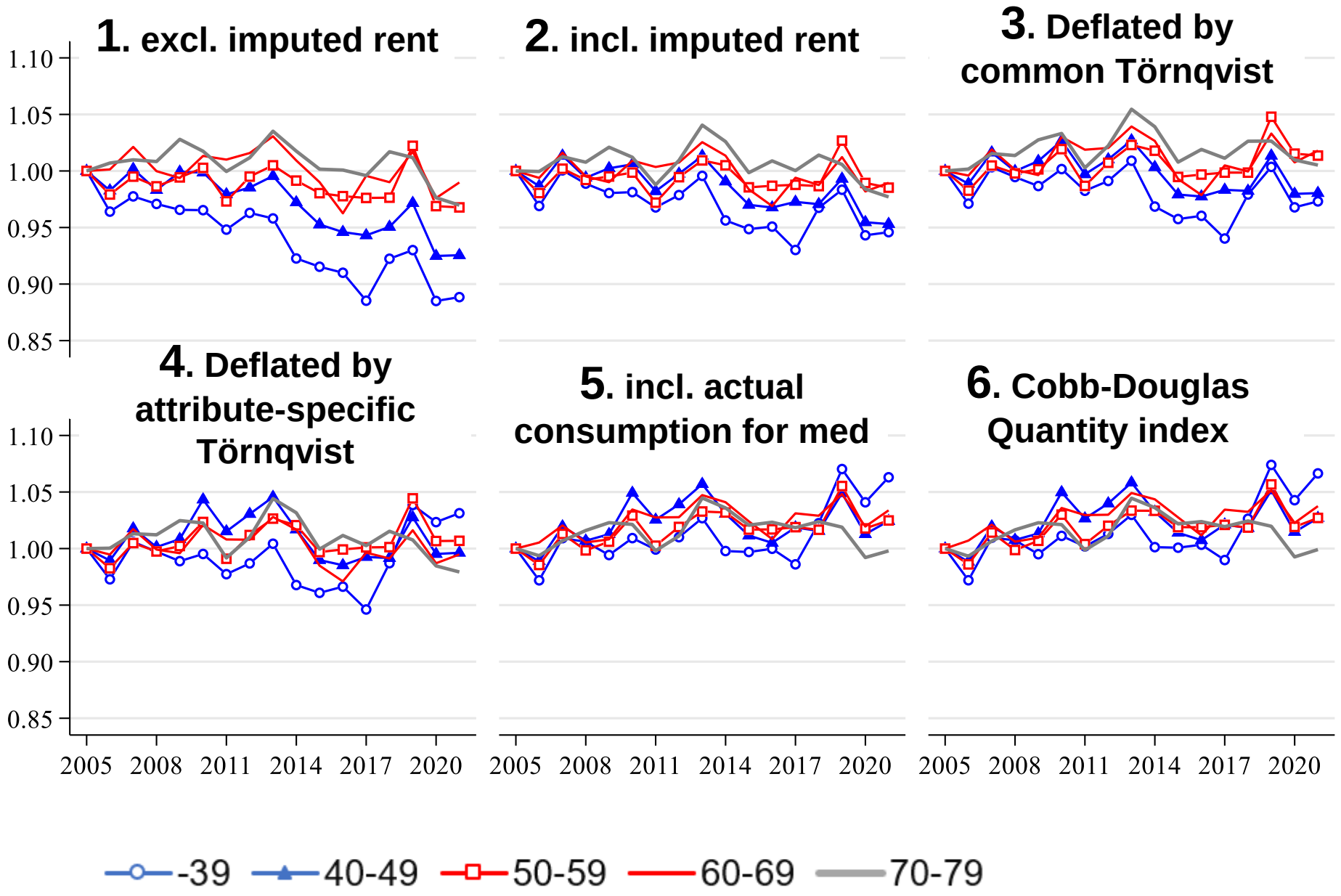
Age-specific α_i

Real Consumption Trends: by Age Category



No.	Imputed rent	Actual consumption for medical services	Price index for deflation
1	✕	✕	Official CPI excl. imputed rent
2	✓	✕	Official CPI
3	✓	✕	Common Törnqvist
4	✓	✕	Attribute-specific Törnqvist
5	✓	✓	Attribute-specific Törnqvist
6	✓	✓	Cobb-Douglas Quantity Index

Real Consumption Trends: by Aggregation Method



Conclusion

The Törnqvist index by household attributes:

- Declined significantly for younger households after October 2019, when free childcare costs for infants began.
- When there are policy changes targeted at specific groups, using a price index common to all household attributes will lead to an overestimate (or underestimate) of the real expenditures of that particular group.

To measure economic welfare:

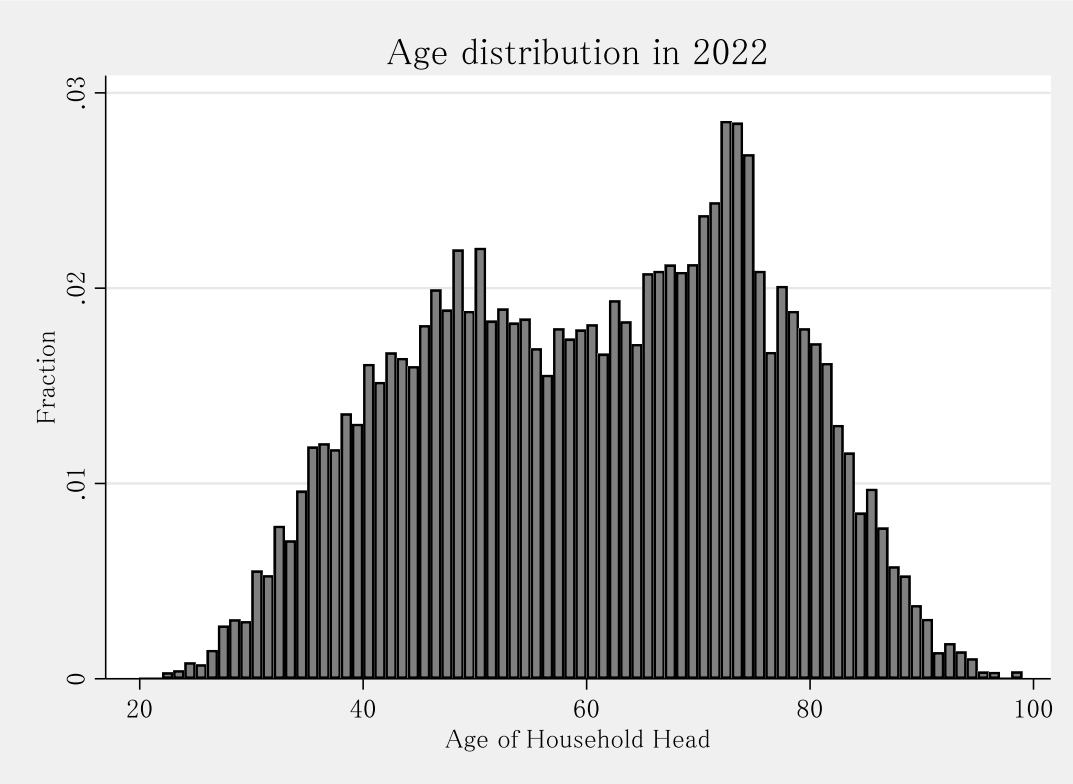
- Estimating household consumption of medical care based solely on out-of-pocket costs is likely to introduce significant measurement errors.

For consumption that has **statistically disappeared** from household expenditures due to policy changes, one method is to use external data to independently estimate the actual consumption for items where spending and consumption do not align.

Appendix

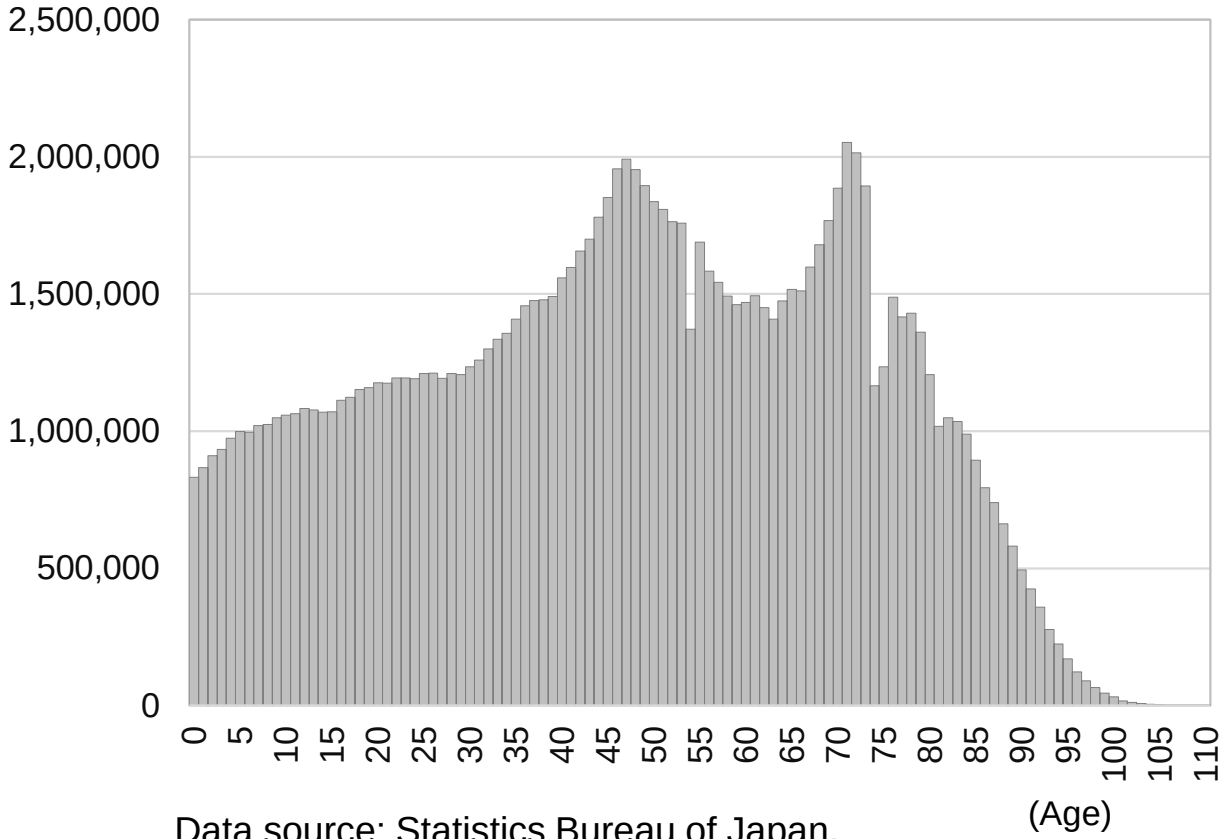
Age Distribution in Japan

Family Income and Expenditure



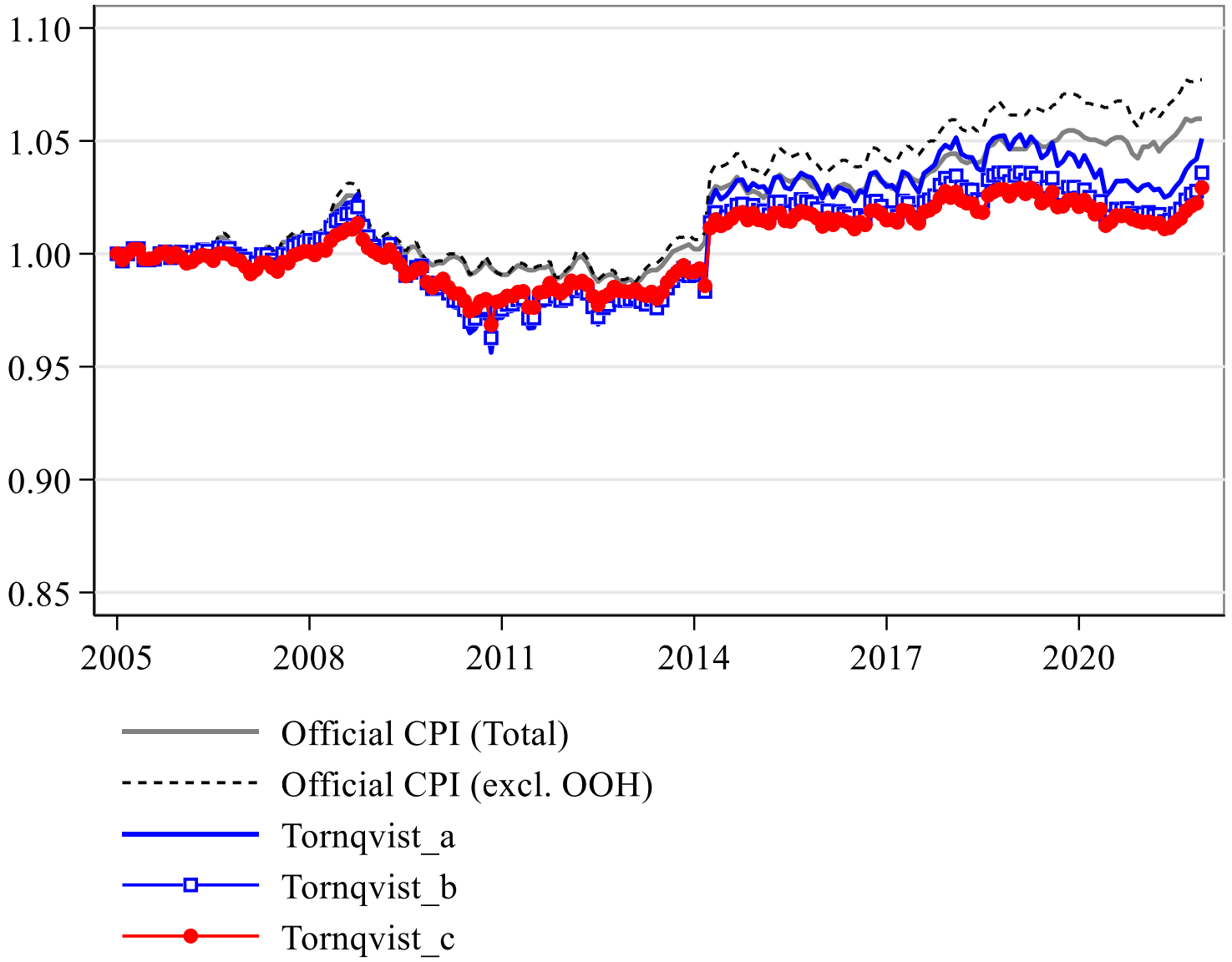
Note: Limited to households with two or more members.

Census (2020)



Data source: Statistics Bureau of Japan, 2020 Population Census.

Price Indices: Törnqvist



Note: Except for the Official CPI, the figures are our estimates based on information from the elementary level CPI and the FIES.

(b) Impute Rent for OOH:

What We did

Data(1) : Household Consumption Expenditure

Variable	Data source	Note
(a) Expenditure by Item	Family Income and Expenditure Survey (**FIES**)	✓ utilizing microdata (# of households / month: about 8,000) ✓ households with two or more members (single-member households is to be added) ✓ limited to households with a head under 80 years old ✓ analysis period: 2005M1-2021M12
(b) Imputed Rent for OOH		✓ Estimate the rent function based on home-ownership, residential area, rent amount, and floor space
(c) Actual Consumption for Medical Services	Estimates of National Medical Care Expenditure (国民医療費)	✓ Nominal medical expenses per capita by age group are published ✓ Match the above medical expenses to households based on the age information of household members

Estimation of Imputed Rent for Owner-Occupied Housing

(1) extract households living in private rental housing

(2) estimate the following rent function for each year (2005–2021)

$$\ln Rent_{i,t} = \alpha_{0,t} + \alpha_{1,t} \ln Floor_{i,t} + \beta_{0,t} D_{i,t} + \beta_{1,t} B^1_{i,t} + \beta_{2,t} B^2_{i,t} + \beta_{3,t} B^3_{i,t}$$

i	: Household ID
t	: Year (2005–2021)
$Rent$	: Private rent (yen/month)
$Floor$	: Total floor area of the dwelling (㎡)
D	: Dummy for Tokyo Special Wards and Ordinance-designated Cities

Regional Block

B^1	: Tokyo
B^2	: Saitama, Chiba, Kanagawa
B^3	: Kyoto, Osaka, Hyogo
B^4	: Other Prefectures (Base category)

The classification of the four regional blocks is based on the estimation method used for the rent function in the "National Survey of Family Income and Expenditure" (conducted every five years by the Ministry of Internal Affairs and Communications)

$$Imputed\ Rent_{i,t} = \exp\left(\widehat{\alpha_{0,t}} + \widehat{\alpha_{1,t}} \ln Floor_i + \widehat{\beta_{0,t}} D_i + \widehat{\beta_{1,t}} B^1_i + \widehat{\beta_{2,t}} B^2_i + \widehat{\beta_{3,t}} B^3_i\right)$$

Estimation of Imputed Rent for Owner-Occupied Housing (cont.)

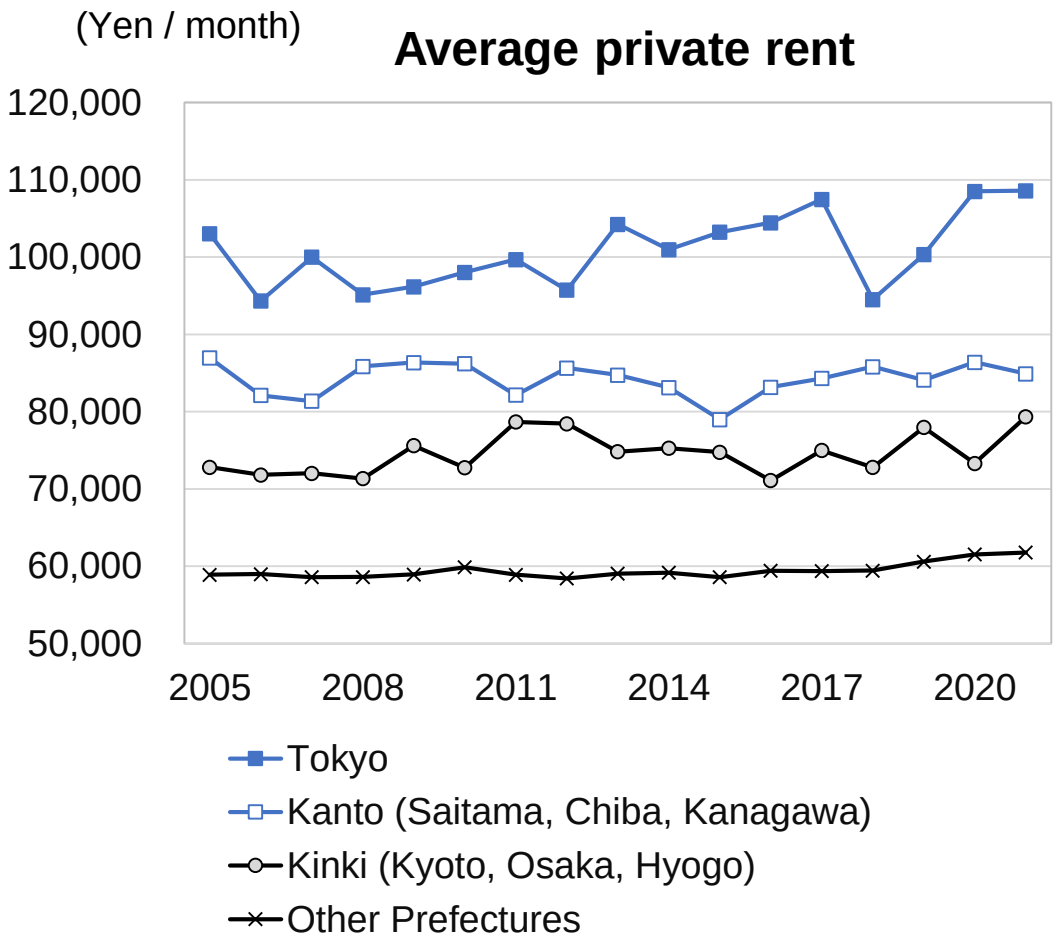
Basic stat of Variables Used for Estimating the Rent Function

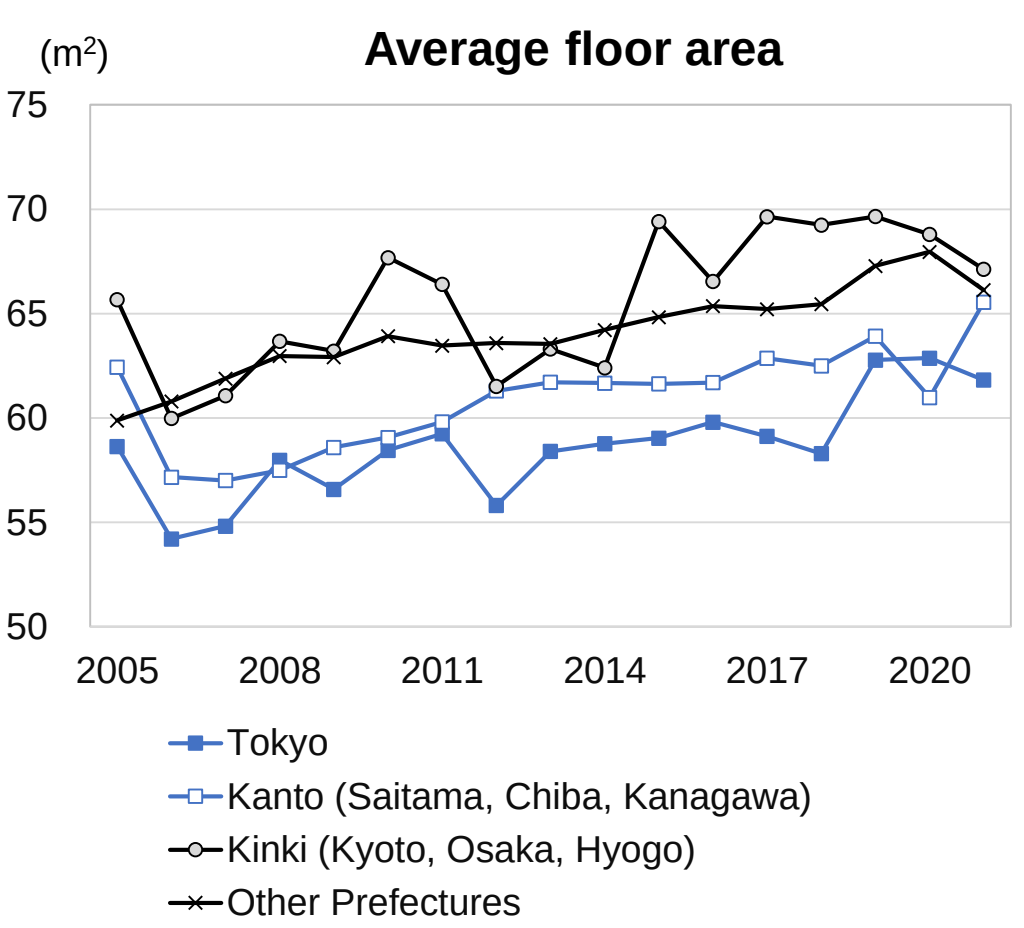
	Mean	Std. dev.	Min	Max
Private Rent (unit: yen/month)	64,859	24,088	15,480	200,000
Floor Area (unit: m^2)	63.5	21.0	25.0	165.0
D: Dummy for Tokyo Special Wards and Ordinance-designated Cities	0.286	0.452	0	1
Dummy for Regional Block				
B^1: Tokyo	0.052	0.221	0	1
B^2: Saitama, Chiba, Kanagawa	0.089	0.285	0	1
B^3: Kyoto, Osaka, Hyogo	0.076	0.265	0	1
B^4: Other Prefectures	0.783	0.412	0	1

Number of observations = 172,762
Note: The data is pooled from 2005 to 2021. Private rent is in nominal terms.

Estimation of Imputed Rent for Owner-Occupied Housing (cont.)

Variables Used in the Estimation of the Rent Function by Regional Block



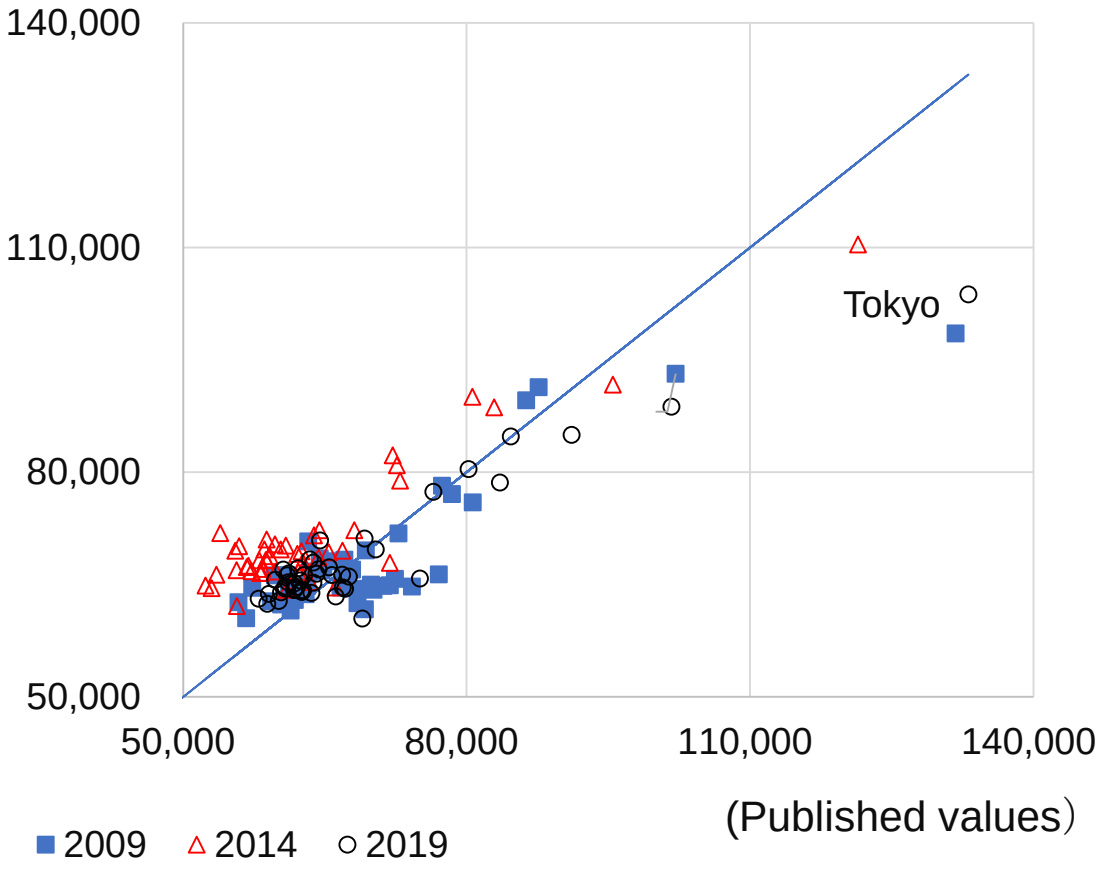


Data source: Family Income and Expenditure Survey conducted by the Ministry of Internal Affairs and Communications.
Note: Averages are simple arithmetic means.

Independent Estimate vs. Published Values

Prefecture-Level Average Imputed Rent for Owner-Occupied Housing

(Original estimate, Unit: yen/month)



Note 1: The published values at the three time points were obtained from the following surveys:

National Survey of Family Income and Expenditure (2009 and 2014)

National Survey of Family Income, Consumption, and Wealth (2019)

Note 2: Data is for owner-occupied households with two or more persons.

(c) Actual Consumption for Medical Services:

What We did

Data(1) : Household Consumption Expenditure

Variable	Data source	Note
(a) Expenditure by Item	Family Income and Expenditure	✓ utilizing microdata (# of households / month: about 8,000) ✓ households with two or more members (single-member households is to be added) ✓ limited to households with a head under 80 years old ✓
(b) Rent for OOH		✓ ership, residential area, rent amount, and floor space
(c) Actual Consumption for Medical Services	Estimates of National Medical Care Expenditure (国民医療費)	✓ Nominal medical expenses per capita by age group are published ✓ Match the above medical expenses to households based on the age information of household members

national-level total expenditure on medical services by age group

Complexity arises because each household has a different age structure.

Method & Numerical Example:

[STEP 1] Merge the per capita average medical expenses according to age for each household member in the FIES.

FIES

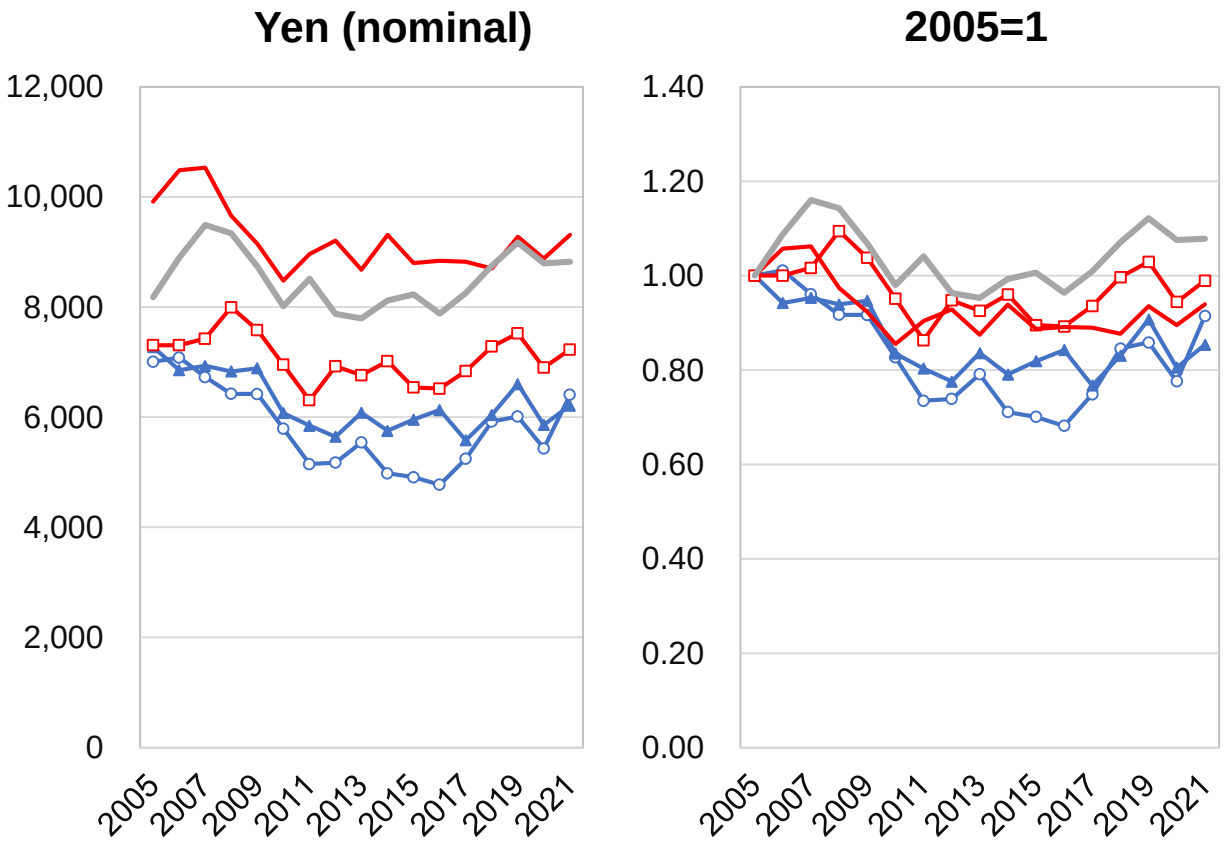
Estimates of National Medical Care Expenditure (conducted by MHLW)

Column 1	Column 2	Column 3	Column 4
Family ID	Expenditure on Medical Services as Recorded in FIES (Unit: 1,000 Yen/Month) $E_{j,t}^{M}$	Age of Each Household Member	Monthly Medical Expenses for the Relevant Age Group, Estimated from the National Medical Care Expenditures $C_{j,t}^{M}$
1	3	0	20
		5	10
		30	10
		40 (HH head)	10
2	0	0	20
		5	10
		30	10
		40 (HH head)	10
3	13	75	60
		80 (HH head)	70

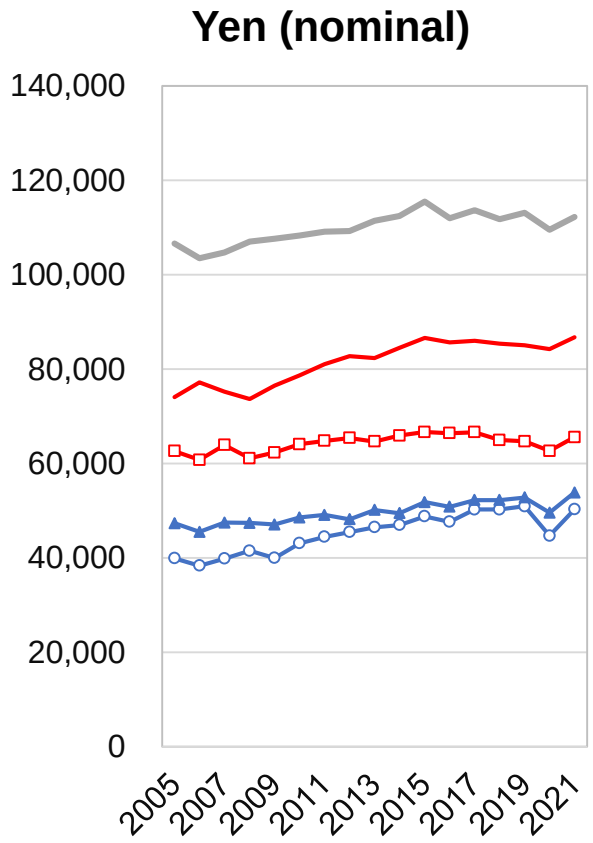
STEP 1

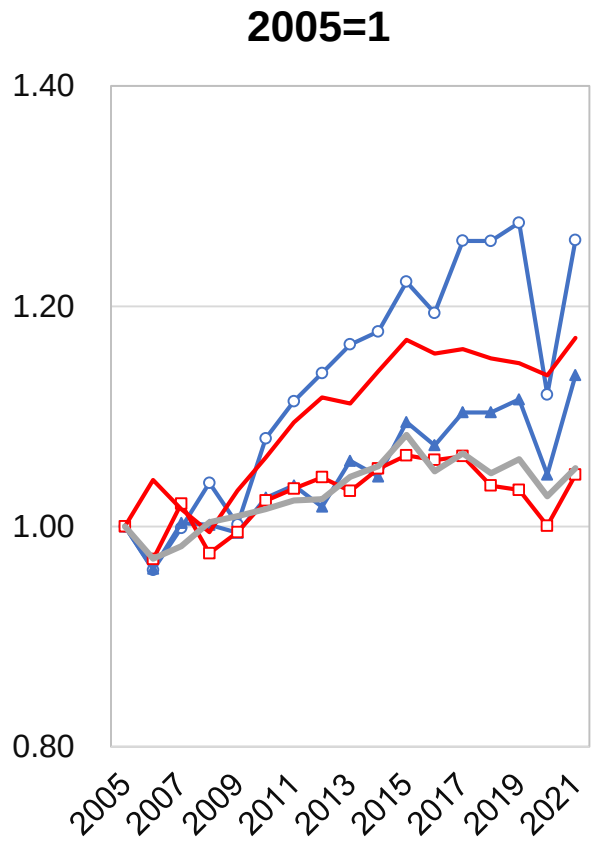
Medical Services:
Expenditure vs. Actual Consumption

Expenditures in FIES



Actual Consumption





-39 40-49 50-59 60-69 70-79