

# Age, Income, Region Specific CPI and Consumption Inequality

**Naohito ABE**  
Hitotsubashi Univ.

**Noriko INAKURA**  
Shikoku Univ.

# Motivation

- ❑ Consumption Inequality has been regarded as one of the most important measures of economic welfare. ([Attansio and Pistaferri, 2016, J. Econ. Perspectives](#))
- ❑ When measuring the inequality, many researchers use the official CPI that is usually treated as the **common deflator among families**.
- ❑ In reality, consumption baskets differ to a great extent among families, depending on their age, income, and region.

The choice of price indices has a significant impact on the **inequality of real values**.

[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.

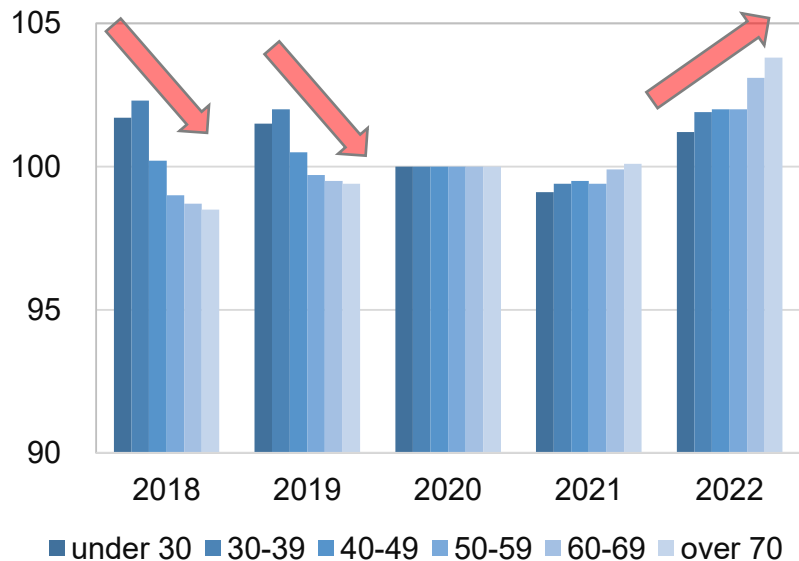
[Moretti \(2013, Applied Econ.\)](#)

Estimating CPI taking into account differences in housing prices by city

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

# From the official CPI (Laspeyres, All items excl. imputed rent)

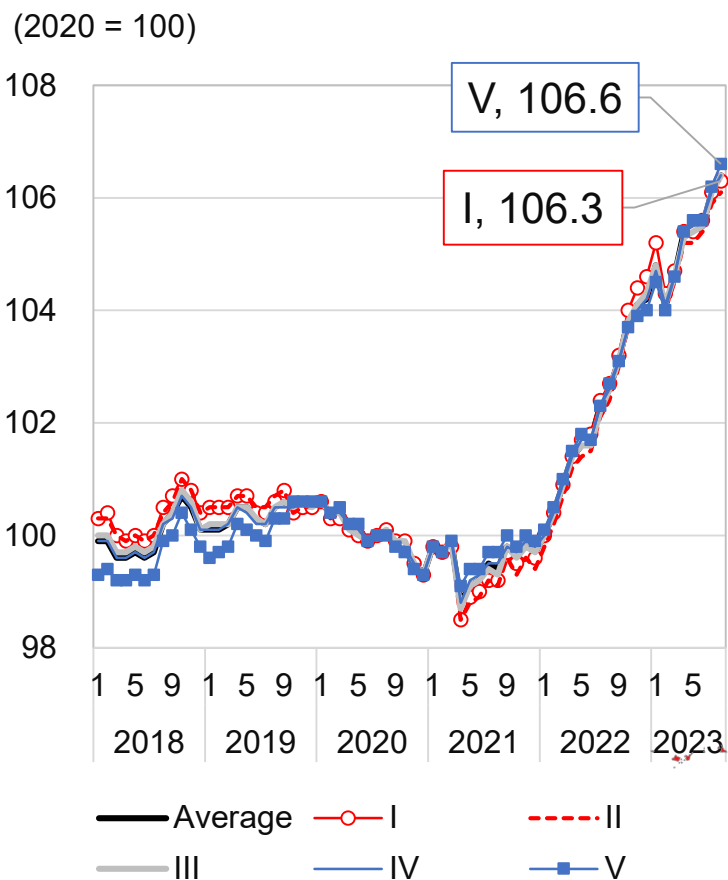
## By Age



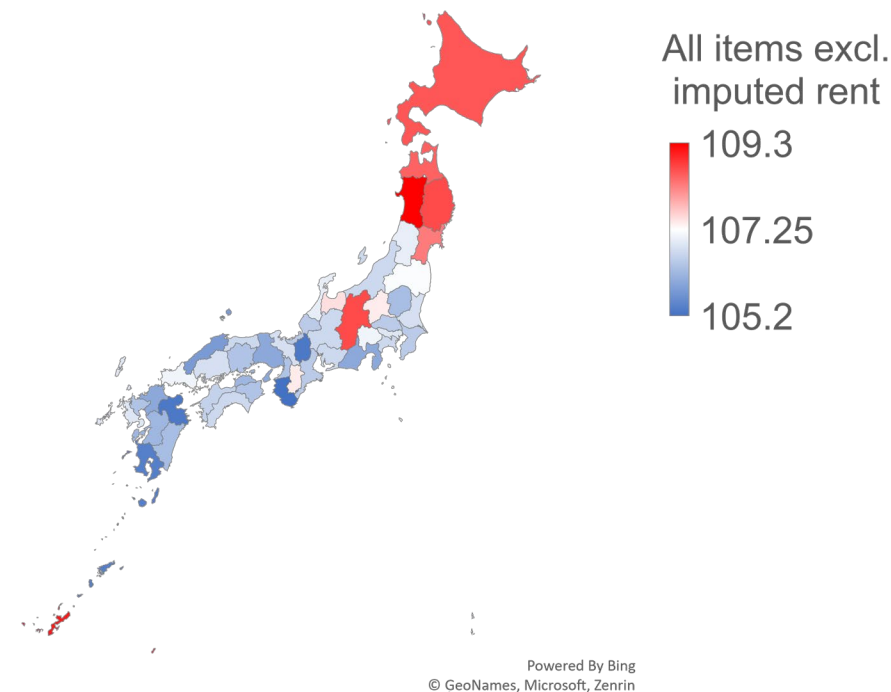
Note: Only the annual average value is available

Data source: Created from the Ministry of Internal Affairs and Communications' "Consumer Price Index"

## By Income



## By Region (August 2023)



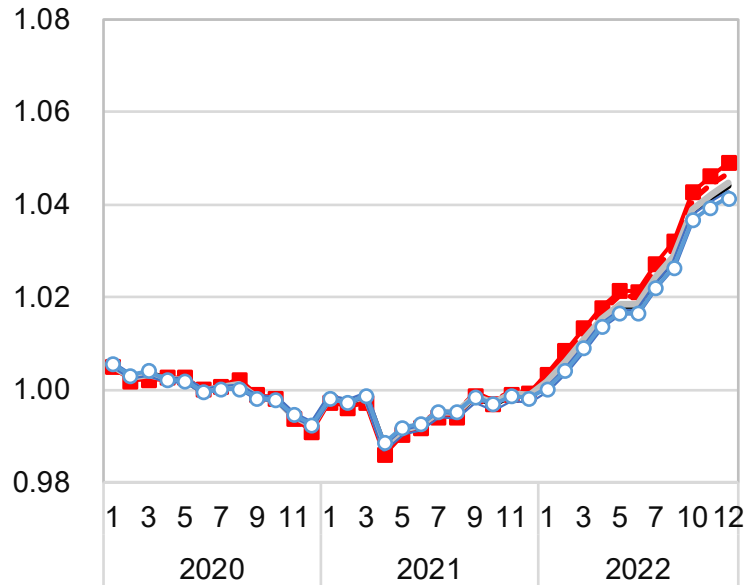
Is it necessary to consider price indices that take into account not just one but **two or more attributes** simultaneously?

# Abe and Inakura (2023), Young index by income-bracket ( I, II, III, IV, V) in each prefecture

(Dec 2022) I-V= 0.008

## Japan

All items excl. imputed rent

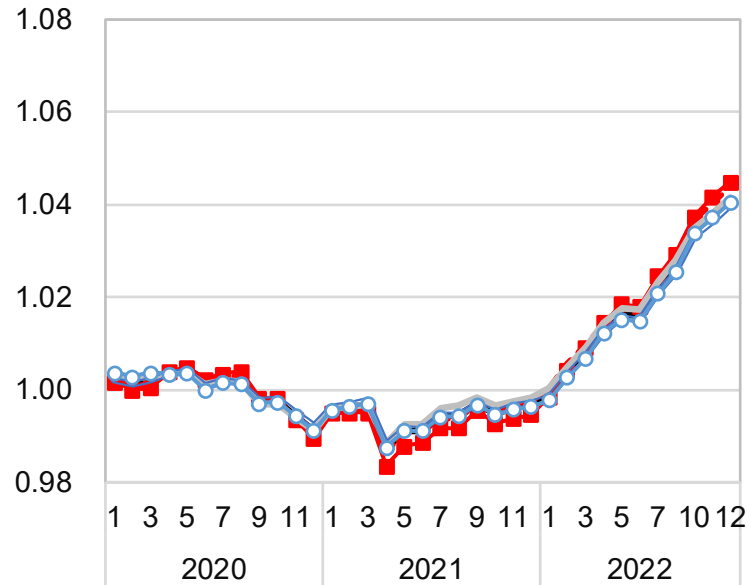


— Total —■ I - - - ■ II — III — IV —○ V

(Dec 2022) I-V= 0.004

## Tokyo

All items excl. imputed rent

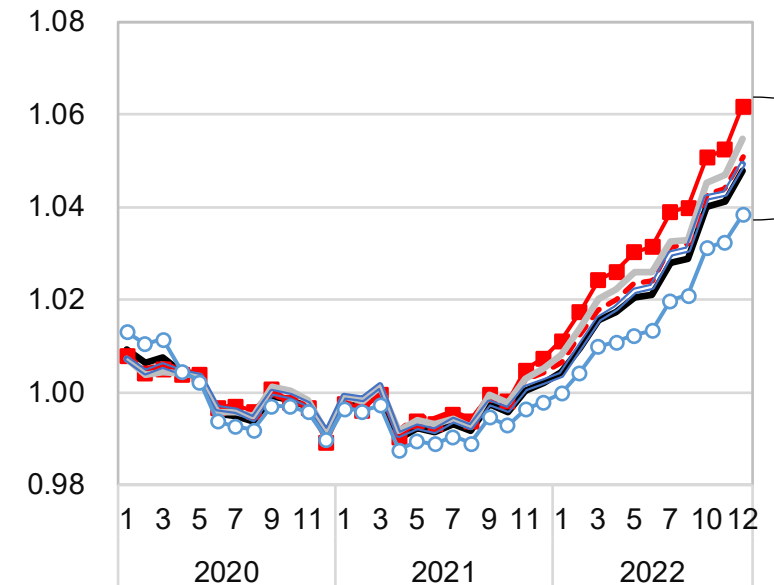


— Total —■ I - - - ■ II — III — IV —○ V

(Dec 2022) I-V= 0.023

## Miyagi

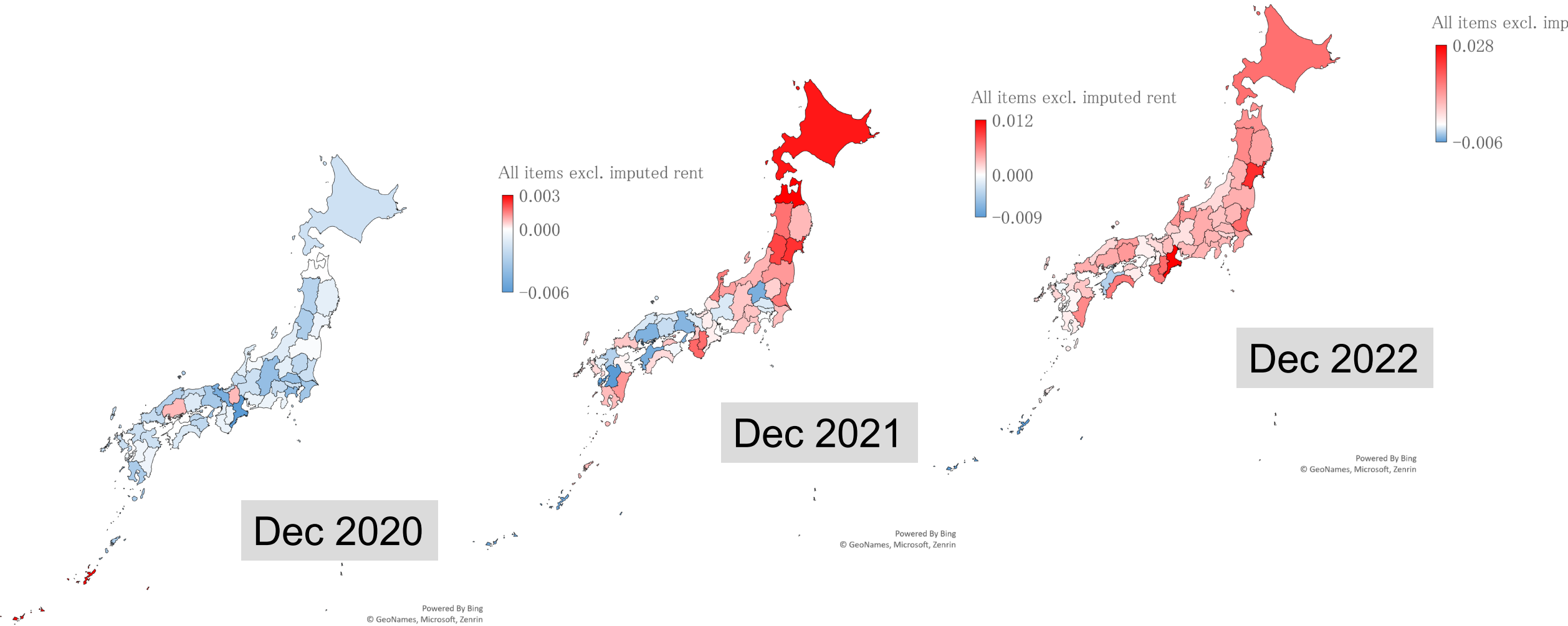
All items excl. imputed rent



— Total —■ I - - - ■ II — III — IV —○ V

Data source: Estimates by Abe and Inakura (2023) from the Ministry of Internal Affairs and Communications' "National Family Income and Expenditure Survey (2019)", "Household Survey," and "Consumer Price Index."

cont. I – V (All items excl. imputed rent)



Data source: Estimates by Abe and Inakura (2023) from the Ministry of Internal Affairs and Communications' "National Family Income and Expenditure Survey (2019)", "Household Survey," and "Consumer Price Index."

# The Purpose of Our Study

In considering **inflation inequality**, it's essential to account for **household-specific expenditures** and **purchase prices**.

Scanner data (e.g., [Kaplan & Schulhofer-Wohl, 2017, J. Mon. Econ.](#)) and credit card payment histories (e.g., [Cavallo, 2020, NBER WP](#)) provide valuable information for this purpose.

However, these data sources have limitations:

- ✓ Limited to specific product categories (e.g., groceries and daily necessities).
- ✓ Questionable representativeness of respondents.
- ✓ Low coverage of expenditure data.

Our research utilizes microdata from official statistics:

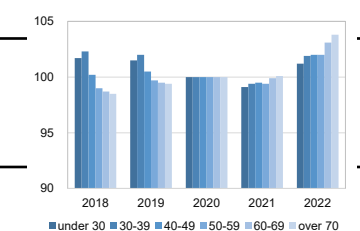
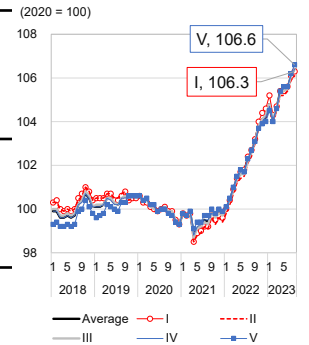
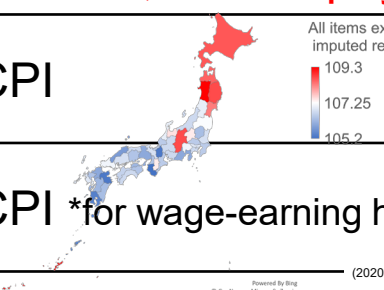
- ✓ Covering all consumption categories, **including services**.
- ✓ Targeting a representative sample of households (approximately 8,000 households monthly).
- ✓ Utilizing high-precision household-specific expenditure data by diary basis.

**Our purpose** is to clarify how the choice of price indices impacts the measurement of inequality in real consumption expenditure.

# How many indices do we attempt to calculate?

Slide for Laspeyres,  
Paasche, Fisher

No.	Age (6 category)	Income (5)	Region (8)	# of Price Indexes	note
000	0	0	0	1	<- corresponds to the 'national average' of the official CPI Note: we are calculating <b>Fisher, not Laspeyres.</b>
001	0	0	1	8	<- published in the official CPI
010	0	1	0	5	<- published in the official CPI *for wage-earning households only
011	0	1	1	40	
100	1	0	0	6	<- published in the official CPI
101	1	0	1	48	
110	1	1	0	30	
111	1	1	1	240	( = 6*5*8)



# Household characteristics used for index calculation

<b>Age</b> (of the head of household)
under 40
40-49
50-59
60-69
70-79
over 80

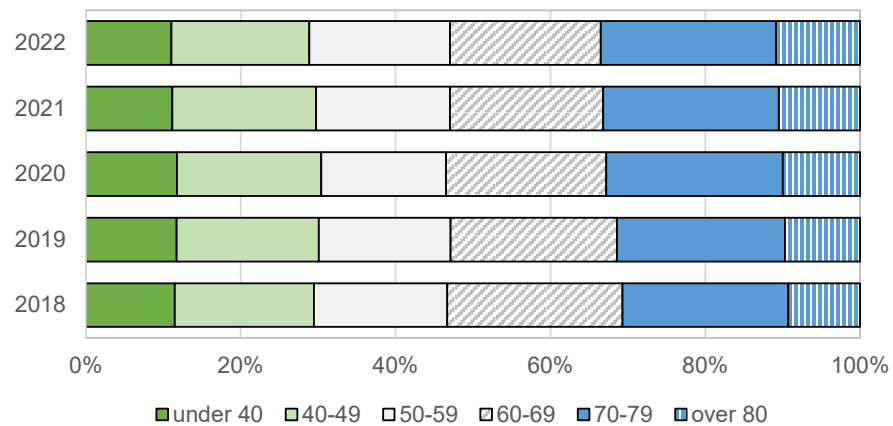
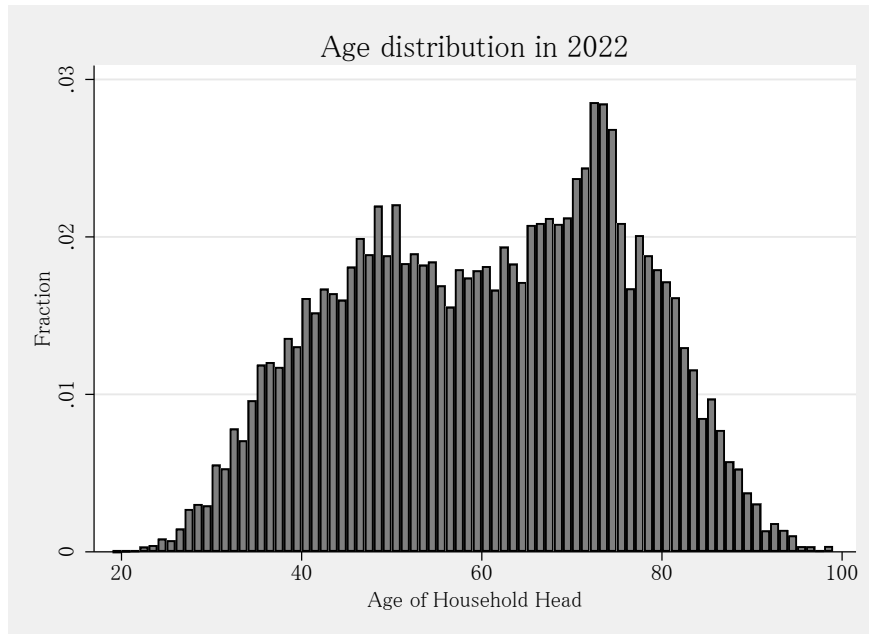
<b>Household income</b>
I
II
III
IV
V

<b>Region</b>
Hokkaido & Tohoku
Kanto
Hokuriku
Tokai
Kinki
Chugoku
Shikoku
Kyusyu & Okinawa

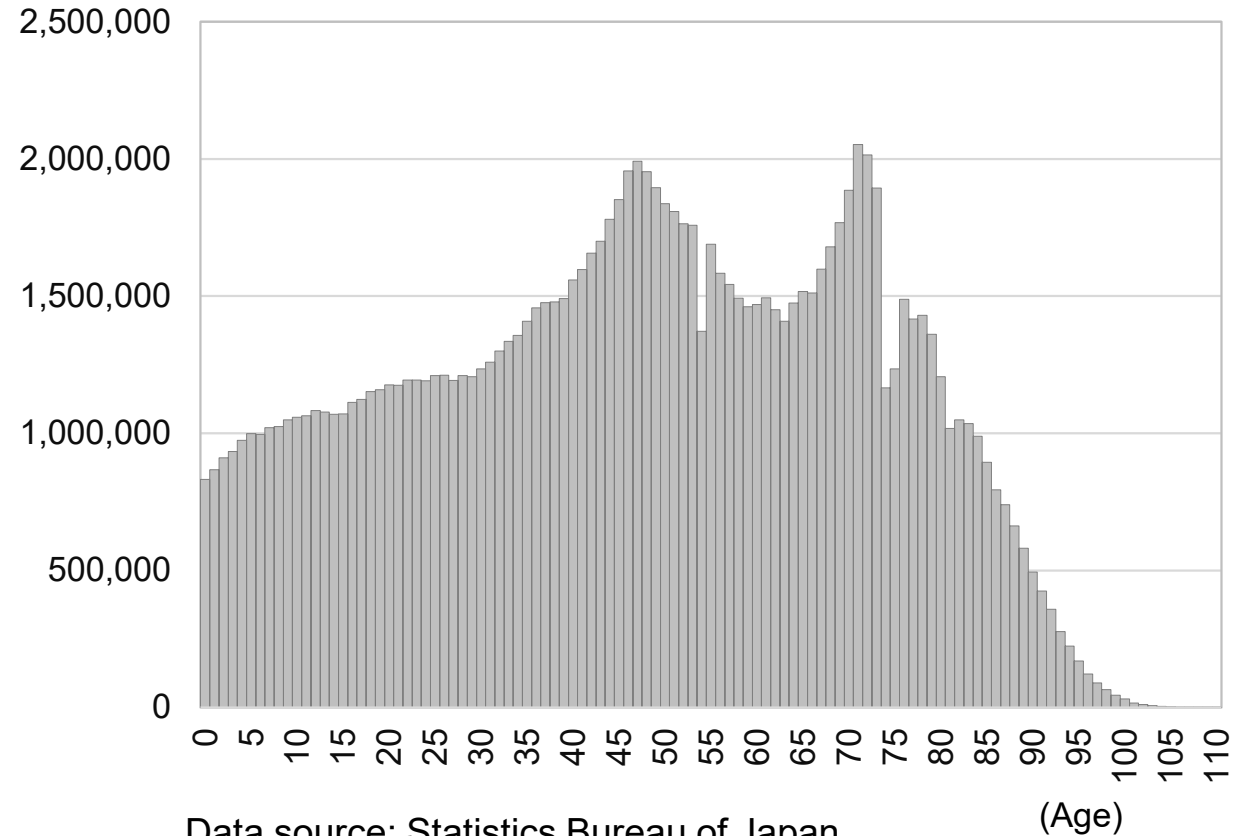


# Age distribution in Japan

## Family Income and Expenditure



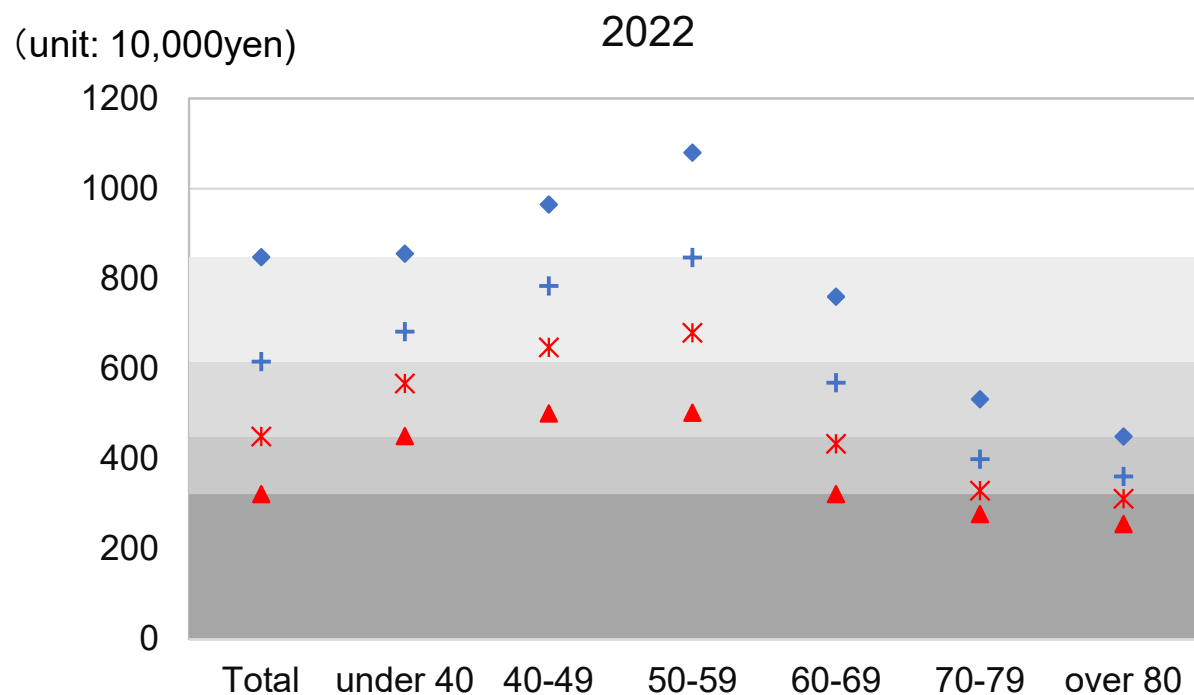
## Census (2020)



Note: Limited to households with **two or more members**.

# Calculation method for income quintiles

Income quintiles are calculated within age categories by year, **not** pooled across all households.



Data source: Estimates from microdata of Family Income and Expenditure (households with two or more members)

# Eight regions

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



# Data

Variable	Data source	Note
<b>Price</b>	Consumer Price Index	<ul style="list-style-type: none"><li>✓ by item (# of items: <b>581</b>)</li><li>✓ national average (prefecture-specific itemized CPI is <b>not</b> publicly available)</li></ul>
<b>Expenditure</b>	Family Income and Expenditure	<ul style="list-style-type: none"><li>✓ utilizing <b>microdata</b> (# of households / month: about 8,000)</li><li>✓ households with <b>two or more members</b> (single-member households is to added)</li><li>✓ analysis period: 2018M1-2022M12 (to be extended)</li></ul>

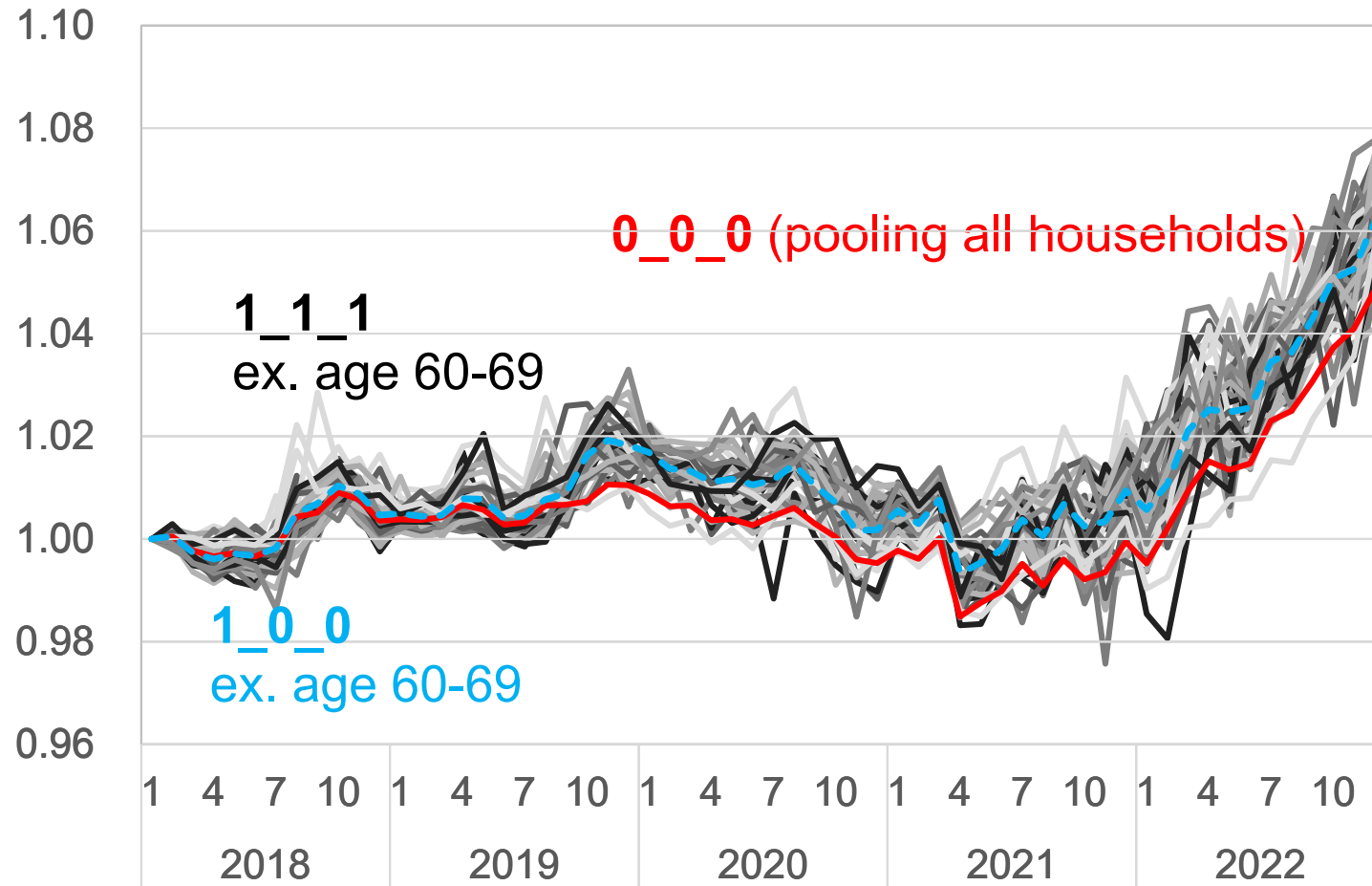
Prices are assumed to be the same for all households, with only expenditure weights differing.

# Method

1. As measures of inequality, we calculate the **logarithmic variance** and **Gini coefficient** for monthly household expenditure.
2. When calculating the **real value** of household expenditures, we use **8 price indices (Fisher)**, ranging from “000” to “111”.
3. We check how the choice of price indices affects inequality.

No.	Age (6 category)	Income (5)	Region (8)	# of Price Indexes
000	0	0	0	1
001	0	0	1	8
010	0	1	0	5
011	0	1	1	40
100	1	0	0	6
101	1	0	1	48
110	1	1	0	30
111	1	1	1	240

# Fisher (000, 010, 001, and 111)









# The Relationship Between Price Indices and Inequality

$C_{i,t}$  : Nominal Monthly Expenditure for attribute  $i$  at time  $t$

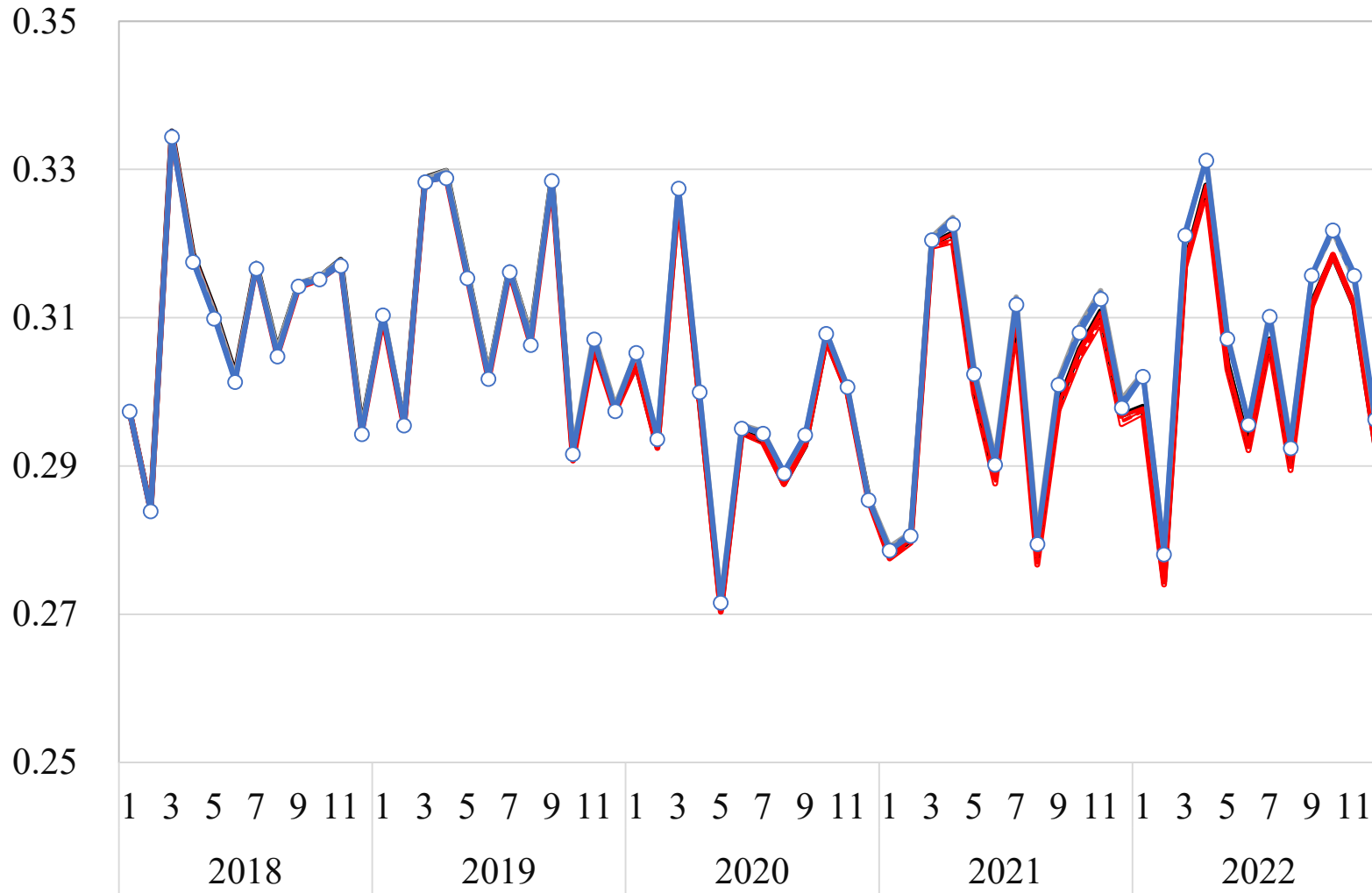
$P_{i,t}^k$  : Price Index for attribute  $i$  at time  $t$

$k = \{000, 001, 010, 011, 100, 101, 110, 111\}$

$Corr(C_{i,t}, P_{i,t}^k)$	Real expenditure	Inequality in real expenditure
$> 0$ (ex. Households with higher nominal consumption expenditures experience higher inflation rates.)	 for rich  for poor	
$< 0$	 for rich  for poor	

# Inequality and Price Index (Fisher): $\text{Var}(\ln(\text{cons}))$

$\text{Var}(\ln(\text{cons}))$



Consumption

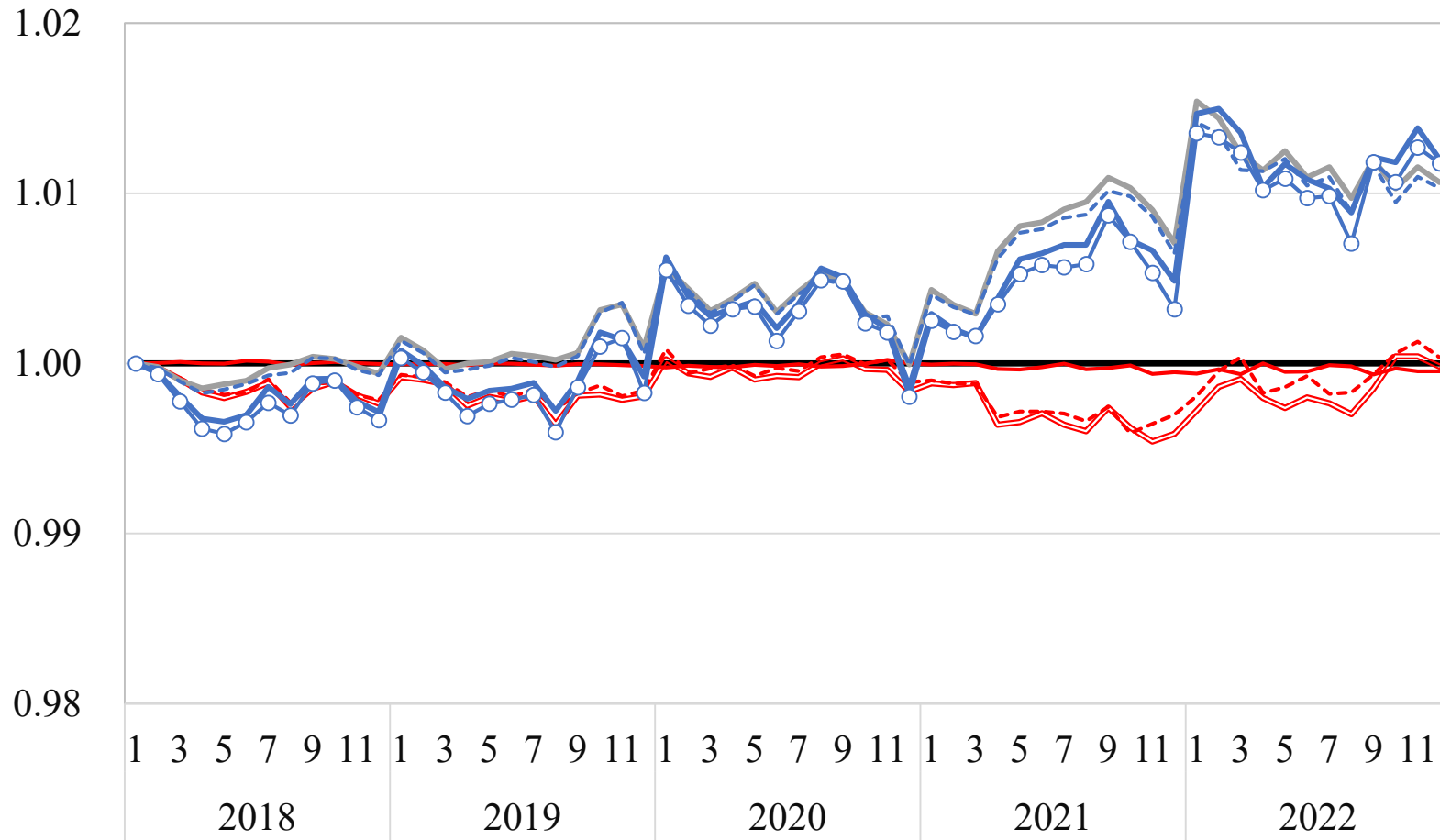
- 0\_0\_0
- 0\_0\_1
- - - 0\_1\_0
- 0\_1\_1
- 1\_0\_0
- - - 1\_0\_1
- 1\_1\_0
- 1\_1\_1

No.	Age (6 category)	Income (5)	Region (8)	# of Price Indexes
000	0	0	0	1
001	0	0	1	8
010	0	1	0	5
011	0	1	1	40
100	1	0	0	6
101	1	0	1	48
110	1	1	0	30
111	1	1	1	240

Data source: Estimates from microdata of Family Income and Expenditure (households with two or more members), and Consumer Price Index.



# Ratio of Real to Nominal: $\text{Var}(\ln(\text{cons}))$



Consumption

No.	Age (6 category)	Income (5)	Region (8)	# of Price Indexes
000	0	0	0	1
001	0	0	1	8
010	0	1	0	5
011	0	1	1	40
100	1	0	0	6
101	1	0	1	48
110	1	1	0	30
111	1	1	1	240

Comparison among Price indices

Slide for Gini coefficient

# Findings & Future Tasks

## Findings:

- ✓ Inequality measurement is influenced by the choice of price index used.
- ✓ During recent periods of rising inflation, not considering **age** tends to underestimate inequality.
- ✓ However, it appears that adding more attributes can either increase or decrease variance of consumption.

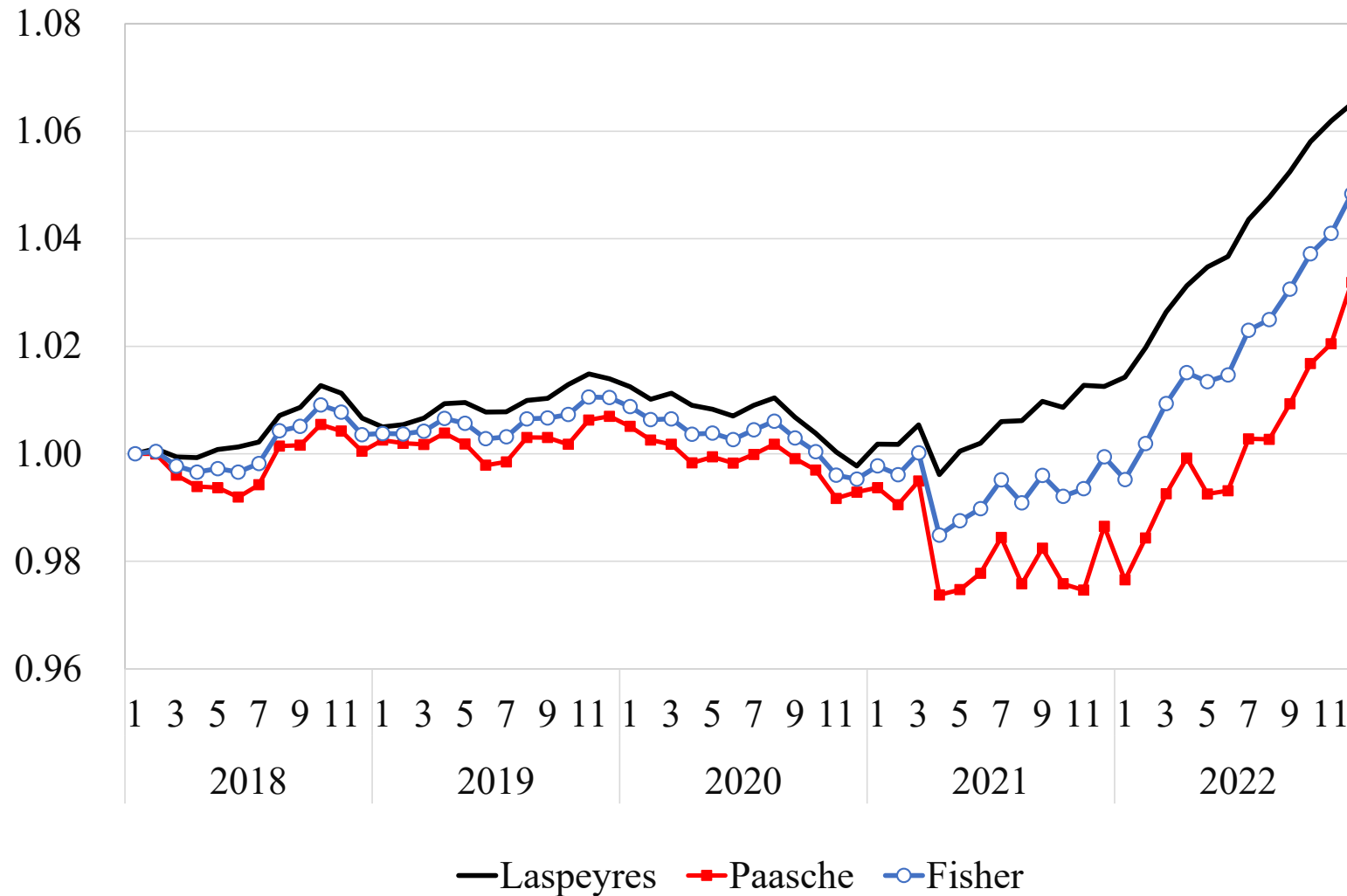
## Future Tasks:

- ✓ Extending the analysis period to examine the impact of factors such as natural disasters and changes in the consumption tax rate on inequality.
- ✓ Calculating price index that takes into account the price differences among the 47 prefectures
- ✓ Considering differences in acquisition prices based on household attributes as much as possible (it may be challenging...)

# Appendix

# Laspeyres, Paasche, and Fisher

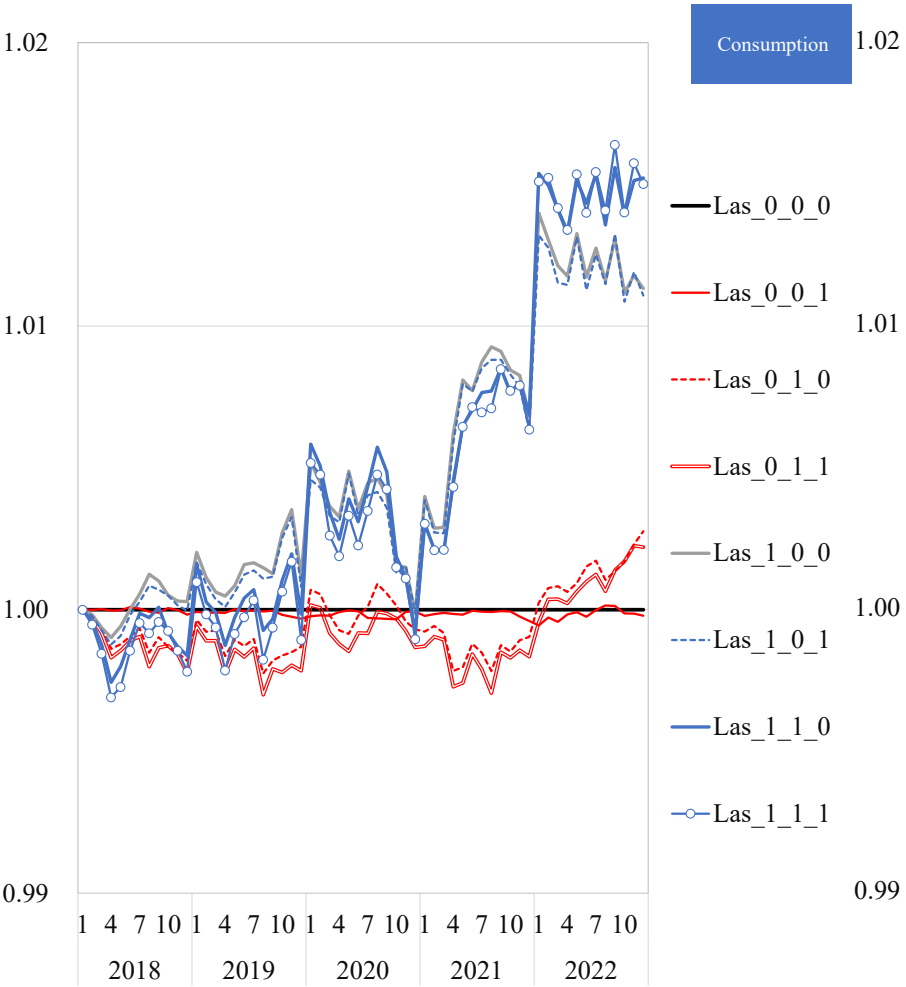
[Back to "How many indices.."](#)



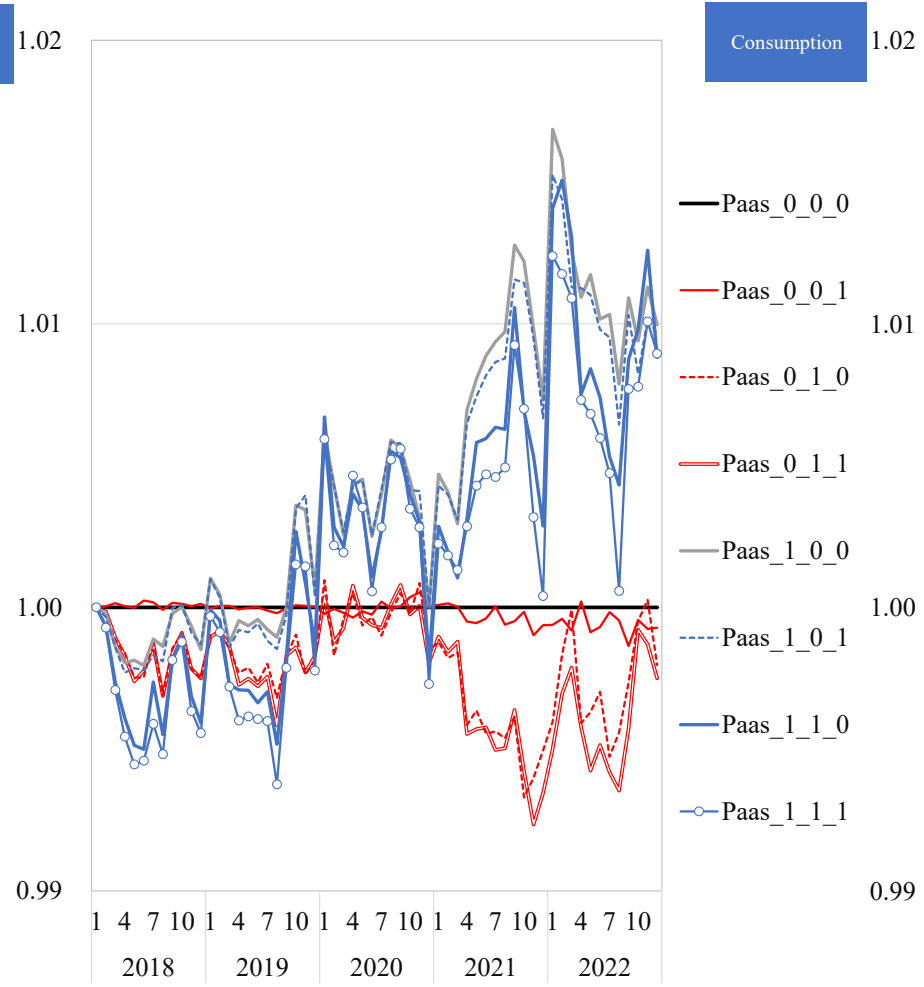
# Ratio of Real to Nominal: $\text{Var}(\ln(\text{cons}))$

Back to log variance

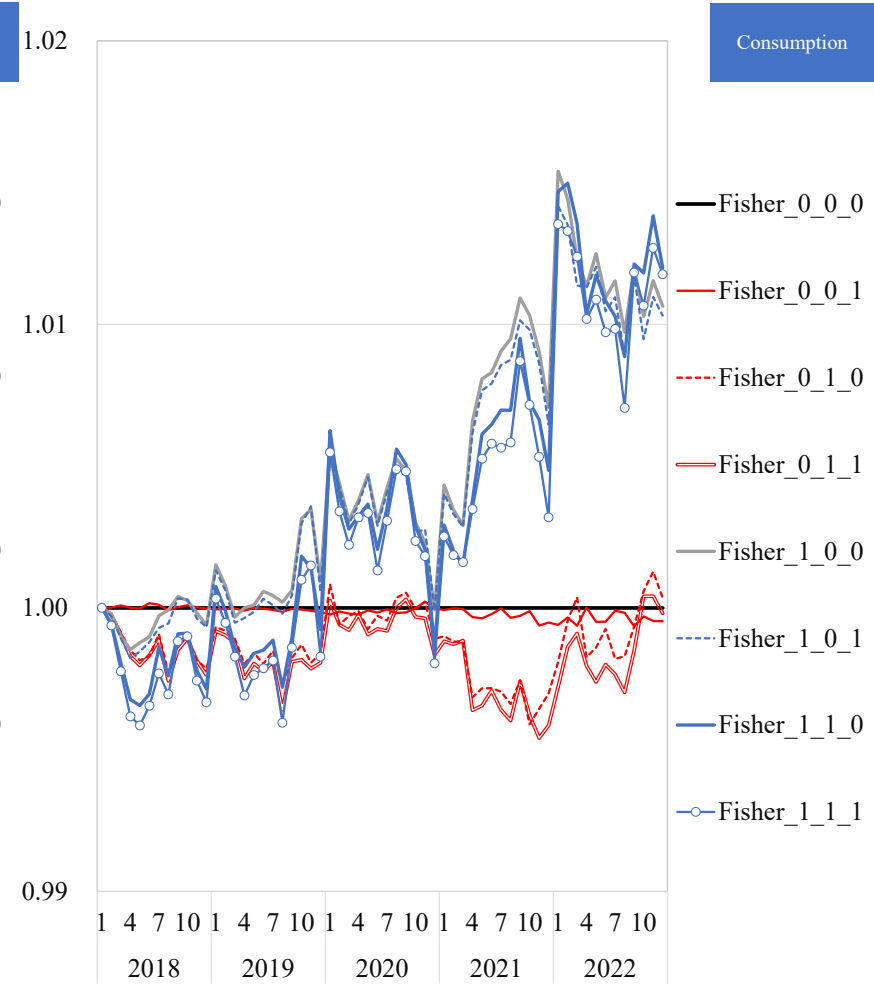
## Deflated by Laspeyres



## Deflated by Paasche



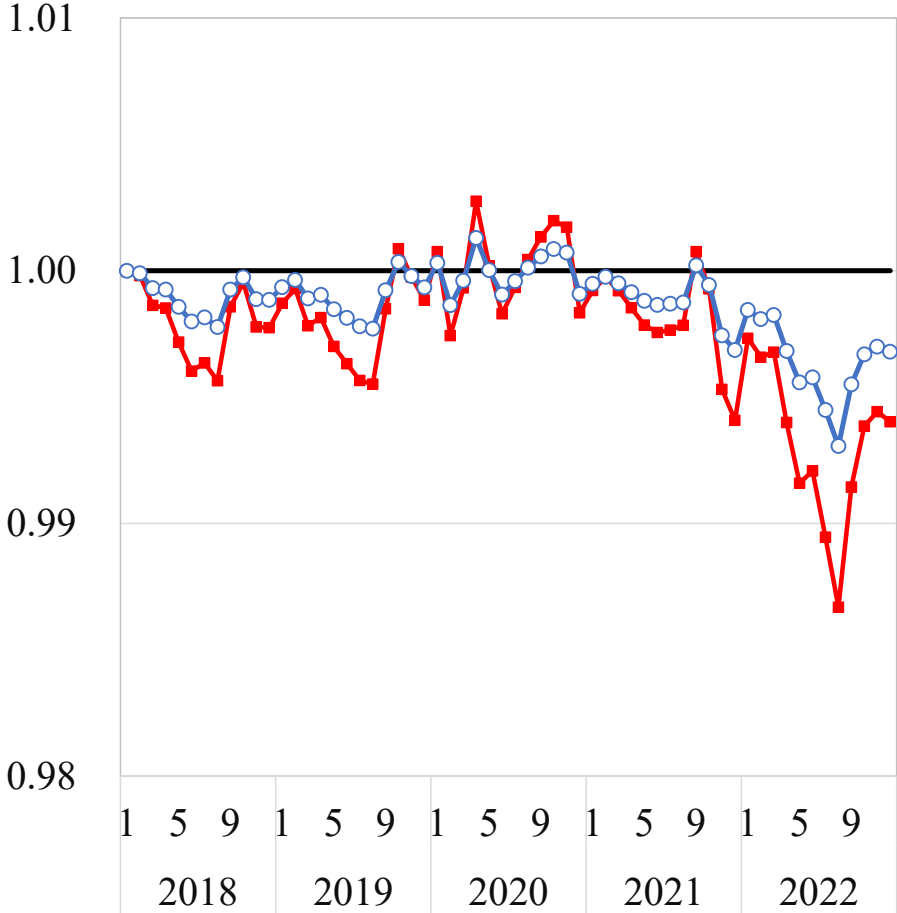
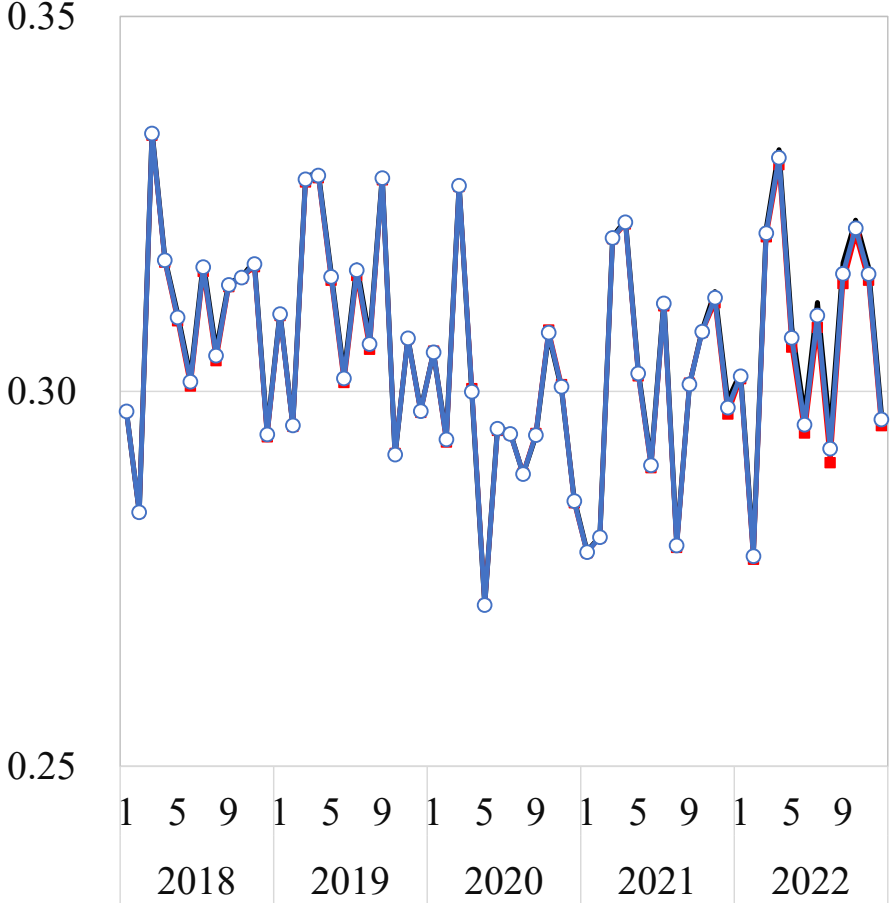
## Deflated by Fisher



# Comparison among Laspeyres, Paasche, and Fisher

[Back to log variance](#)

Var(ln(cons))



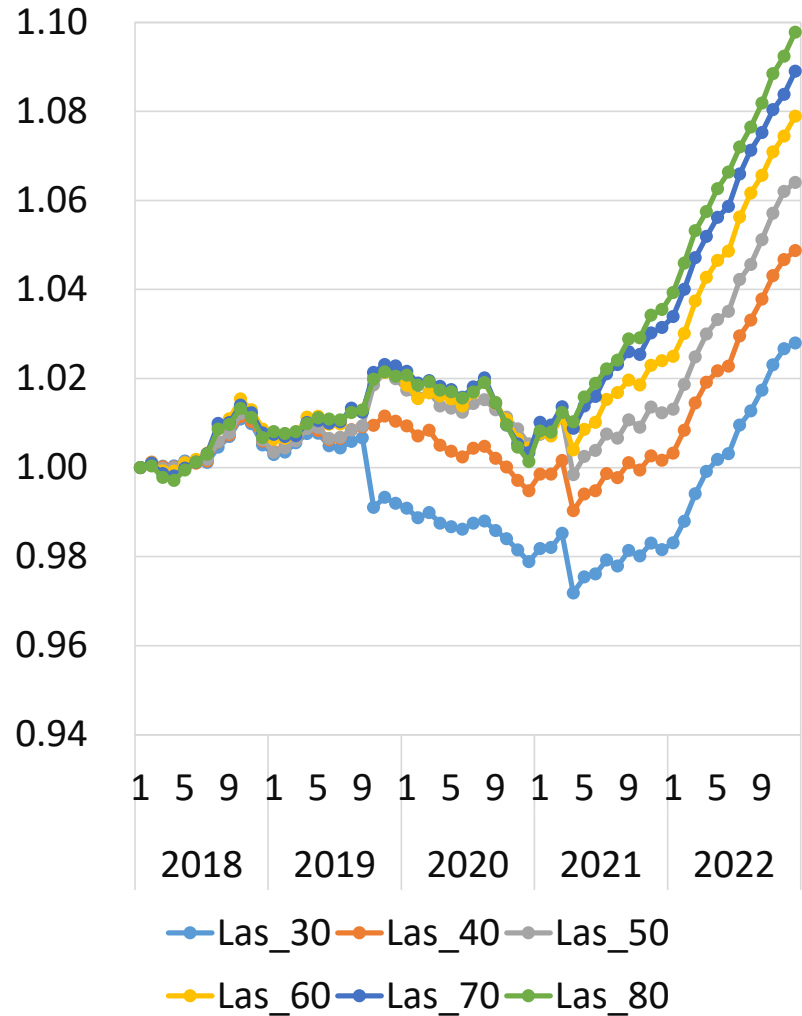
—Las\_1\_1\_1 —Paas\_1\_1\_1 —Fisher\_1\_1\_1

—Las\_1\_1\_1 —Paas\_1\_1\_1 —Fisher\_1\_1\_1

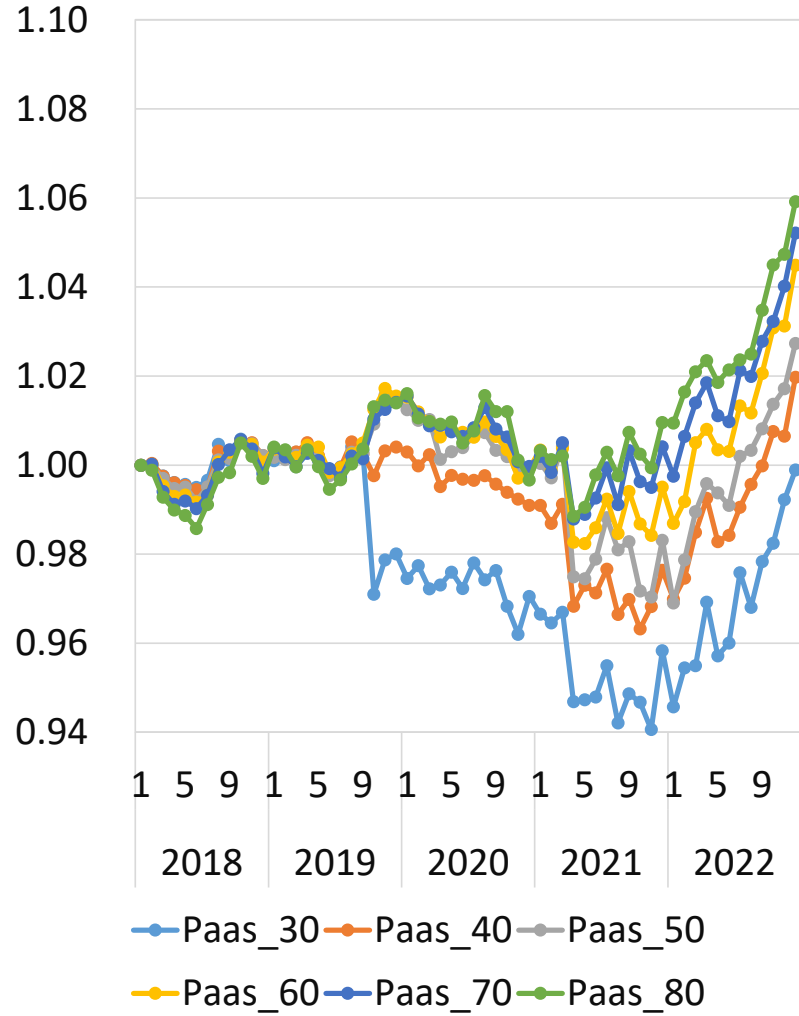
# By Age

[Back to "How many indices.."](#)

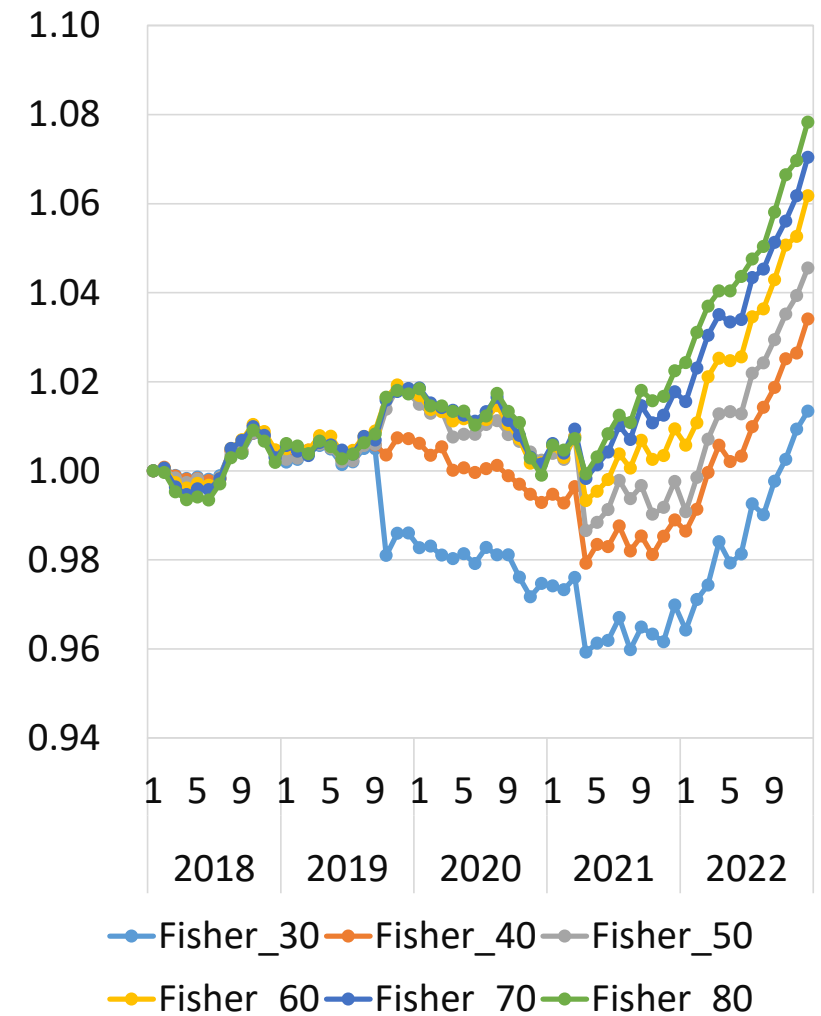
### Laspeyres by Age



### Paasche by Age



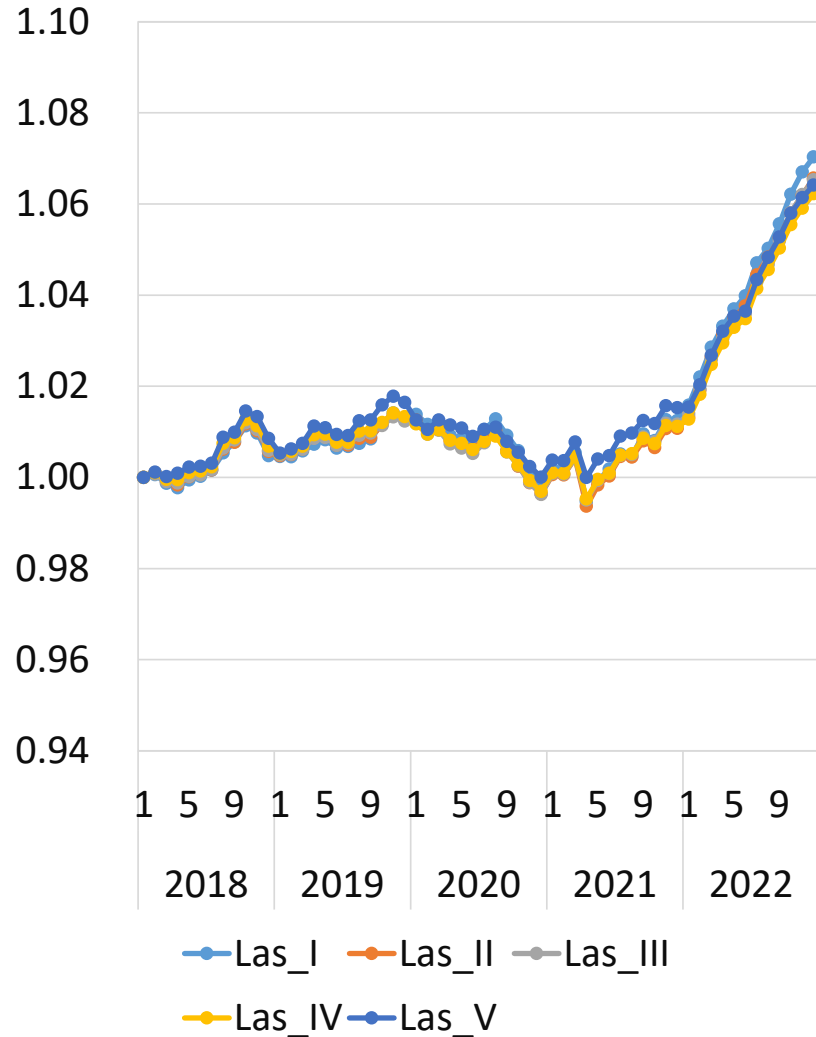
### Fisher by Age



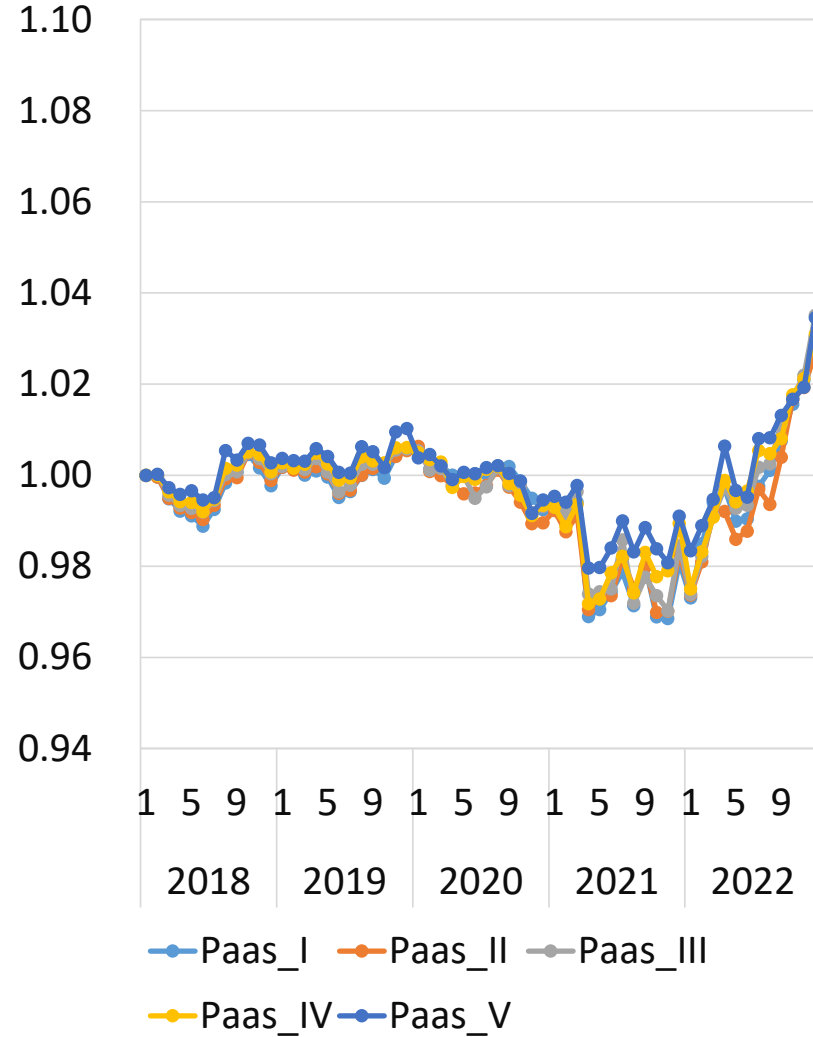
# By Income

[Back to "How many indices.."](#)

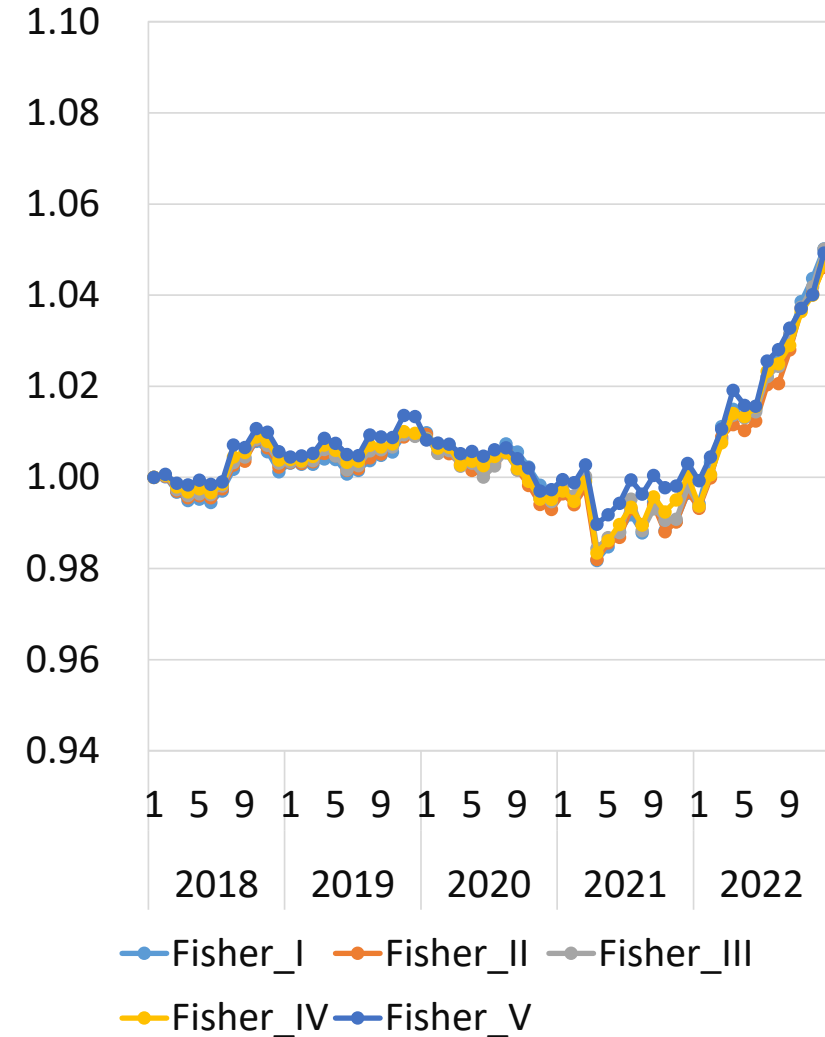
## Laspeyres by Income



## Paasche by Income



## Fisher by Income

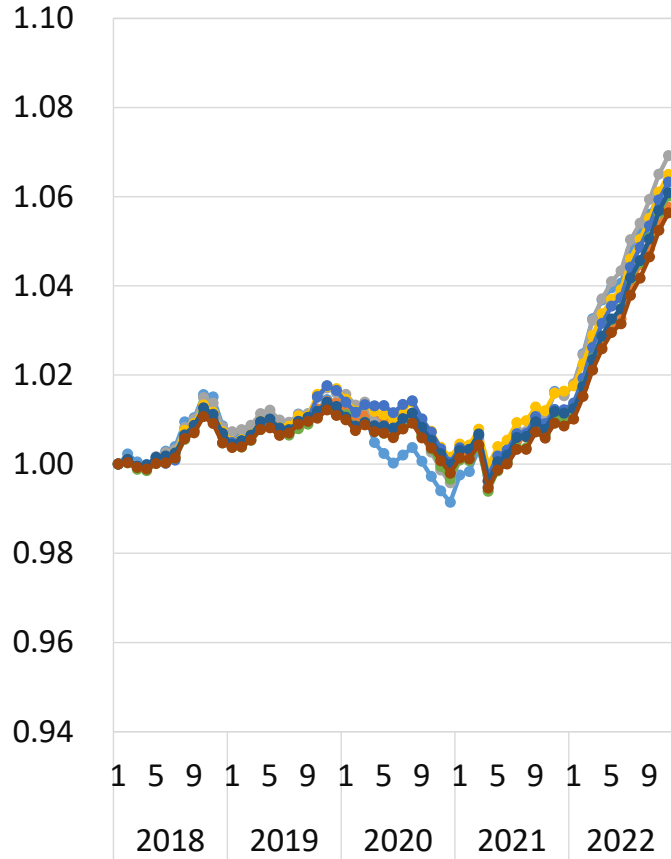




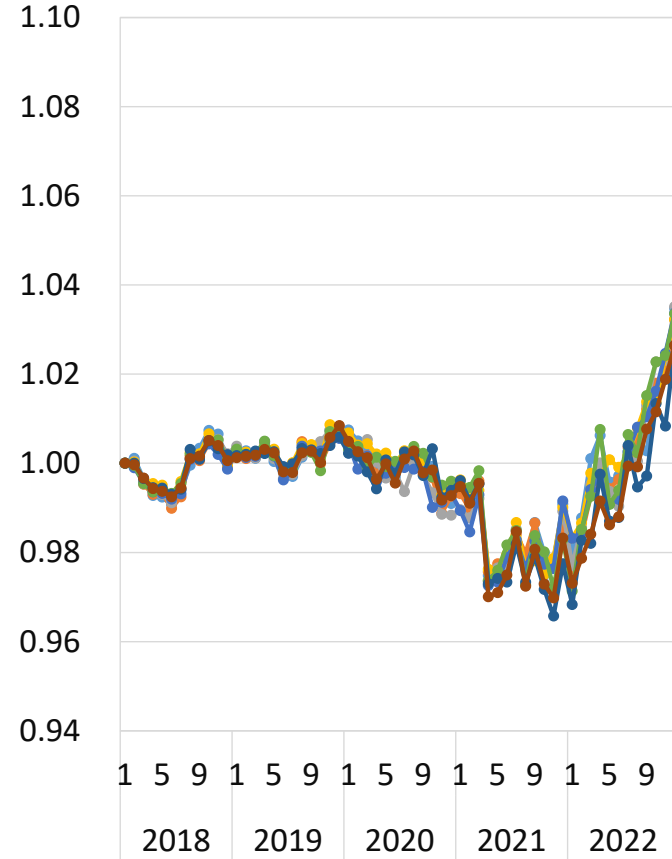
# By Region

[Back to "How many indices.."](#)

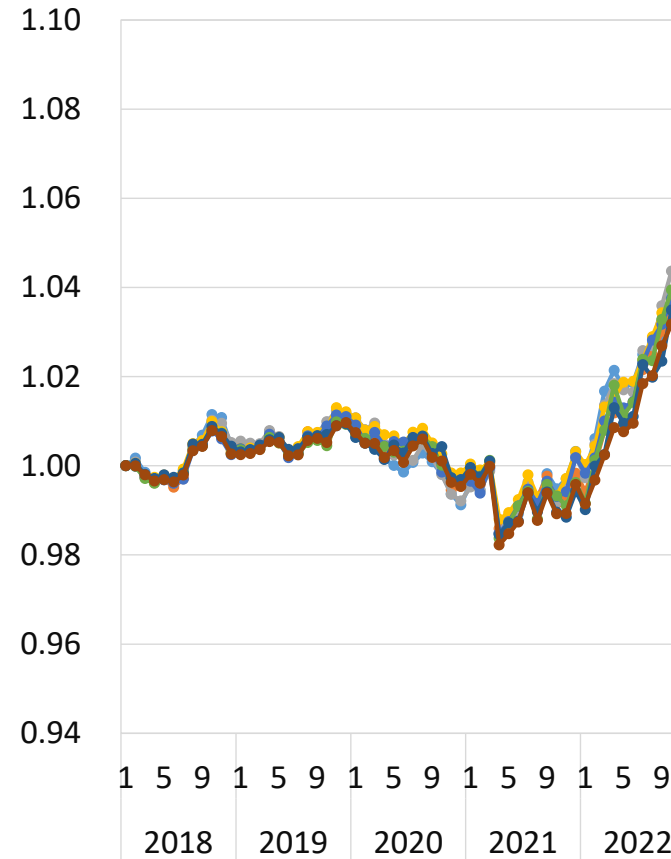
### Laspeyres by Income



### Paasche by Income



### Fisher by Income



- Fisher\_Hokkaido&Tohoku
- Fisher\_Kanto
- Fisher\_Hokuriku
- Fisher\_Tokai
- Fisher\_Kinki
- Fisher\_Chugoku
- Fisher\_Schikoku
- Fisher\_Kyusyu&Okinawa

# Basic statistics for expenditure and income

## Nominal expenditure per month (unit: yen)

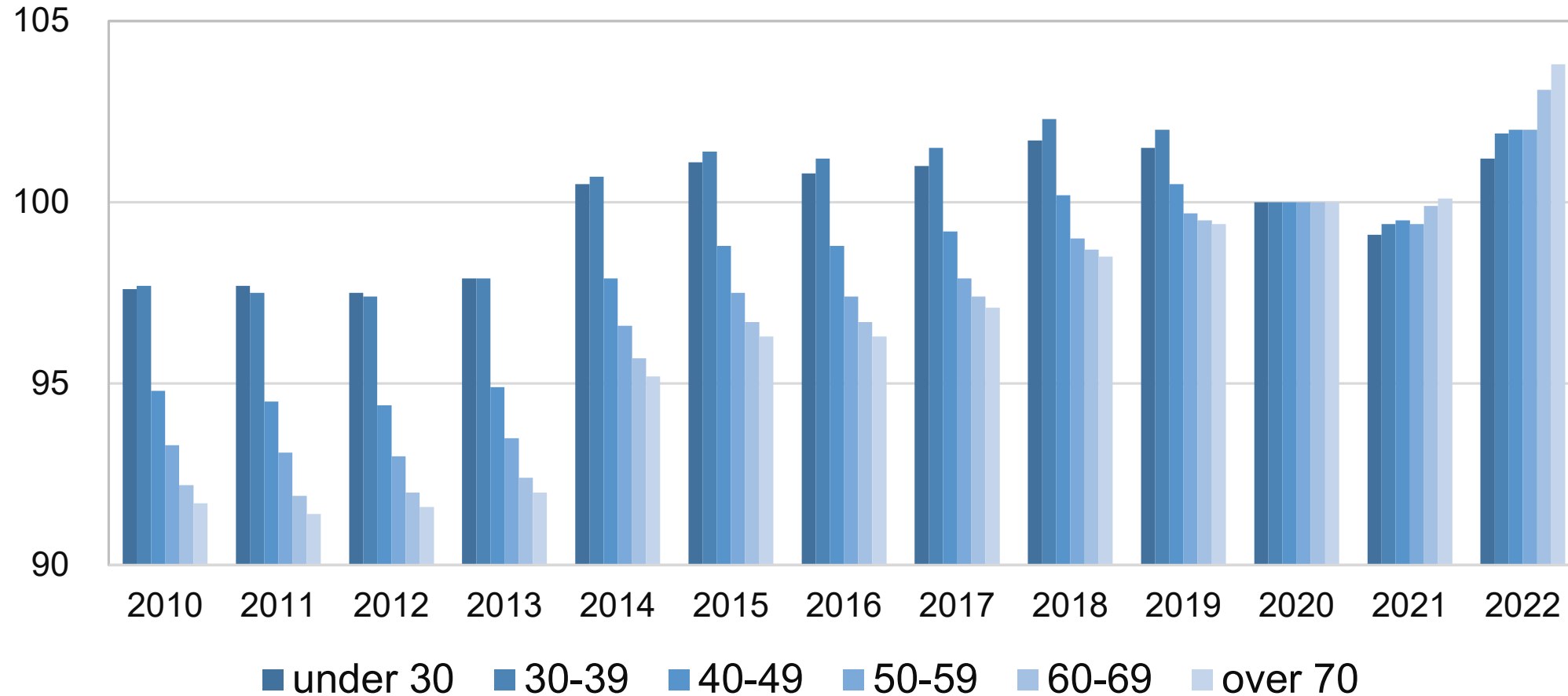
year	N	Mean	p50	SD	Min	Max
2018	91,660	266,858	222,927	235,316	21,461	8,480,584
2019	90,264	271,005	226,274	237,763	21,599	7,935,062
2020	90,051	260,327	217,836	233,492	21,105	6,241,659
2021	89,093	261,561	216,056	241,228	20,350	7,373,000
2022	88,095	271,542	225,162	247,039	20,255	6,983,005

## Nominal household annual income (unit:10,000 yen)

year	N	Mean	p50	SD	Min	Max
2018	91,660	597.8	507.0	377.4	24	8,041
2019	90,264	600.4	512.0	371.9	30	5,700
2020	90,051	609.9	518.0	386.5	27	5,700
2021	89,093	607.7	520.0	370.0	24	5,000
2022	88,095	611.2	529.0	366.1	9	4,678

Data source: From microdata of Family Income and Expenditure  
(households with two or more members)

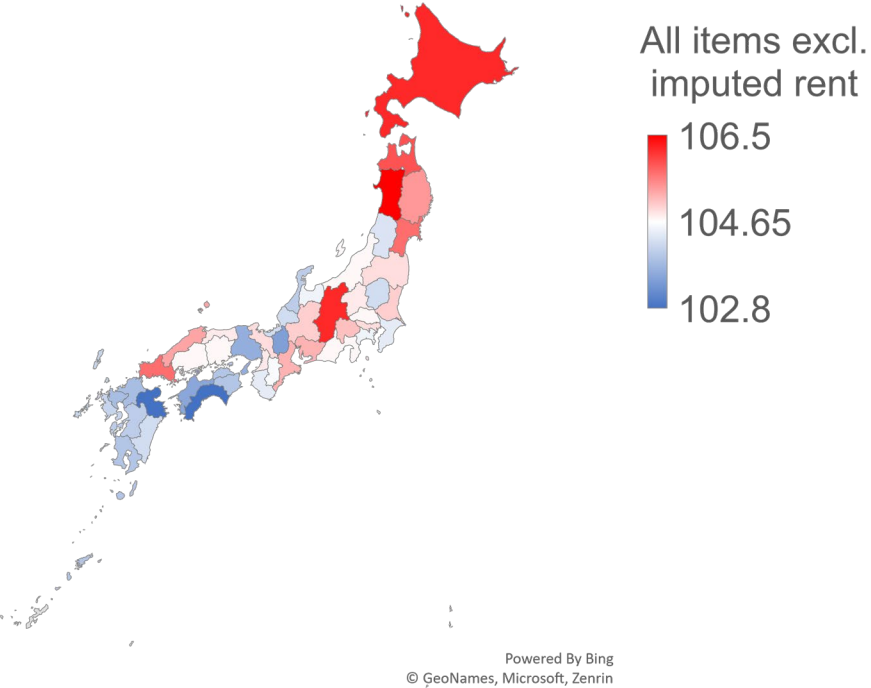
# Official CPI: by age



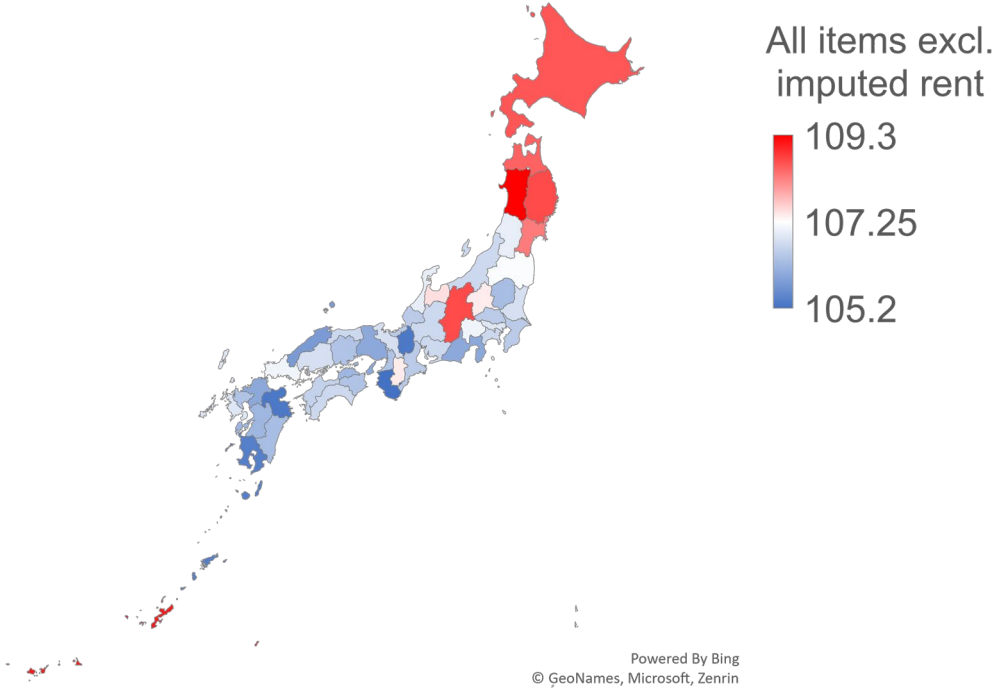
Data source: Created from the Ministry of Internal Affairs and Communications' "Consumer Price Index"

# Official CPI: by region

December 2022



August 2023

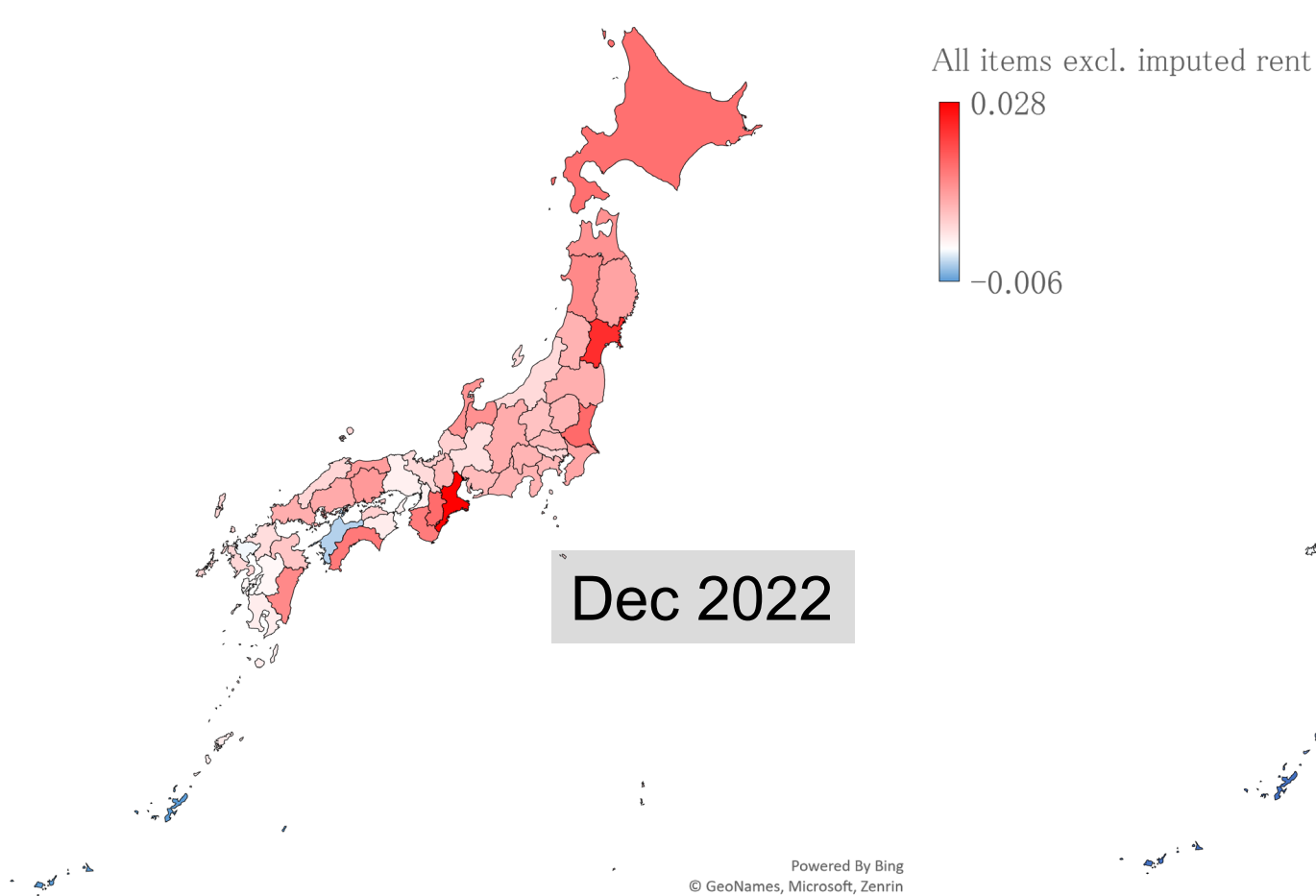


Data source: Created from the Ministry of Internal Affairs and Communications' "Consumer Price Index"

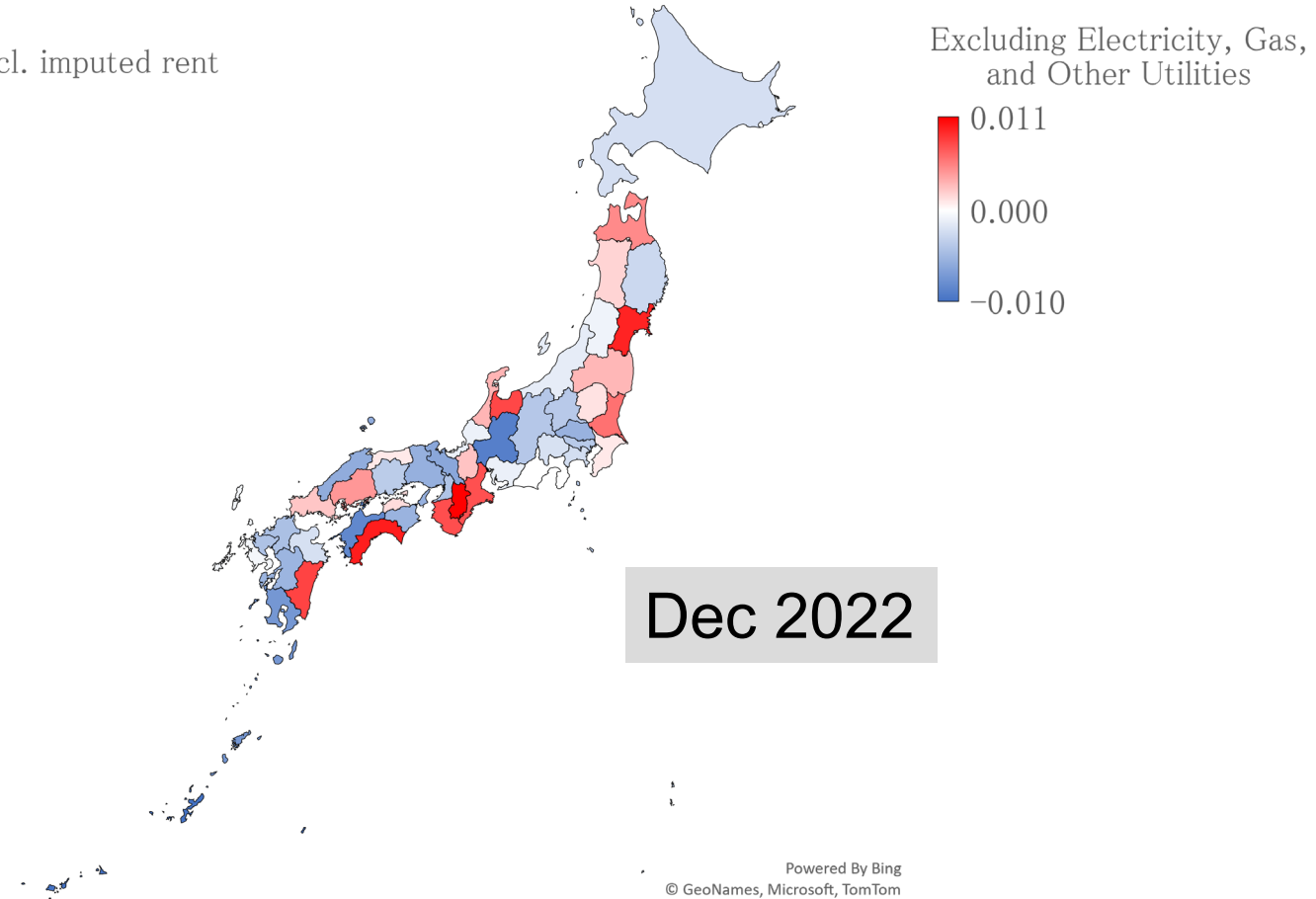
# Impact of Energy Prices (December 2022)

Data source: Estimates by Abe and Inakura (2023) from the Ministry of Internal Affairs and Communications' "National Family Income and Expenditure Survey (2019)", "Household Survey," and "Consumer Price Index."

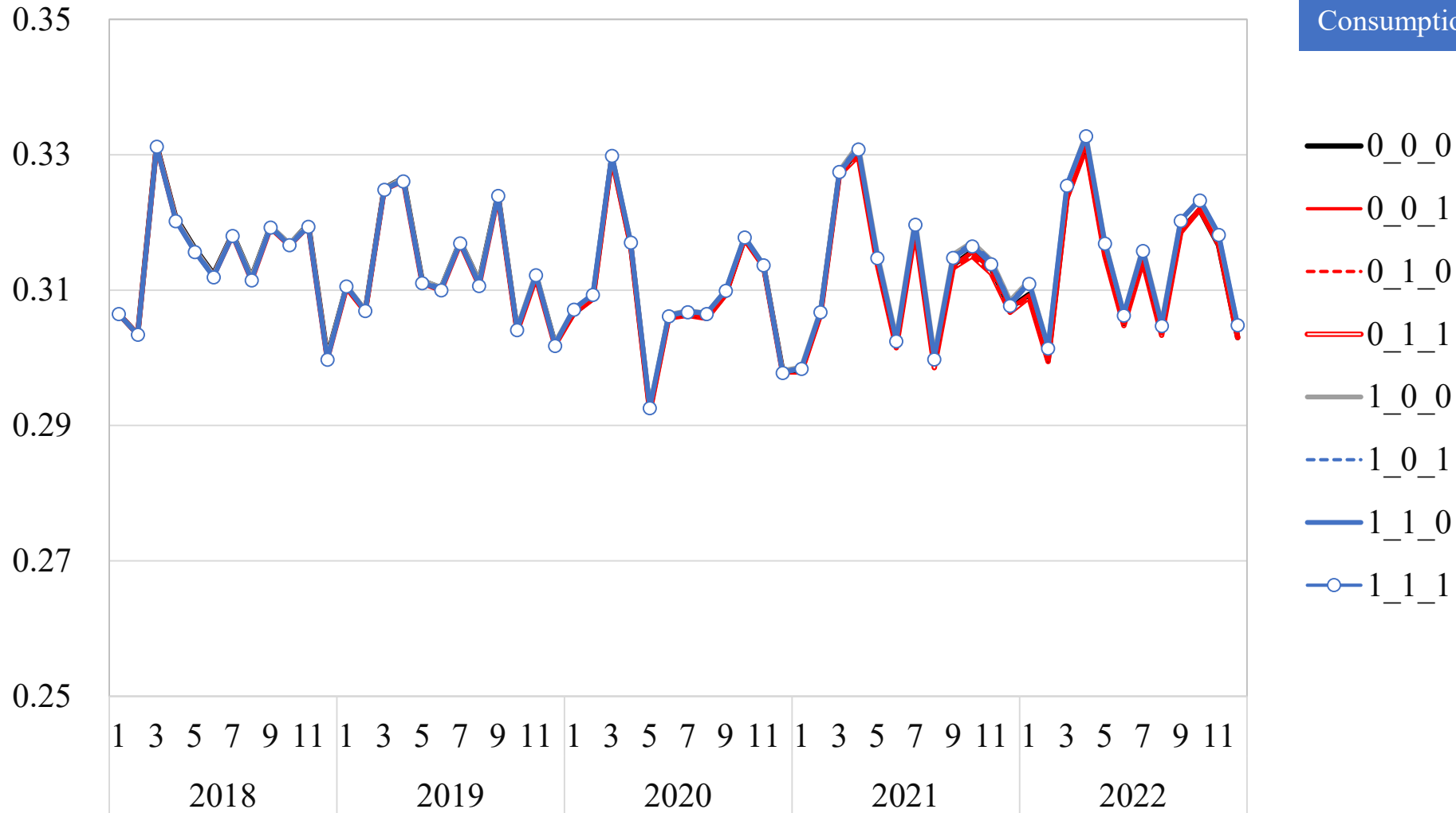
## A. All items, less imputed rent (I-V)



## B. Excluding Energy-Related Items from A



# Inequality and Price Index (Fisher): Gini coefficient

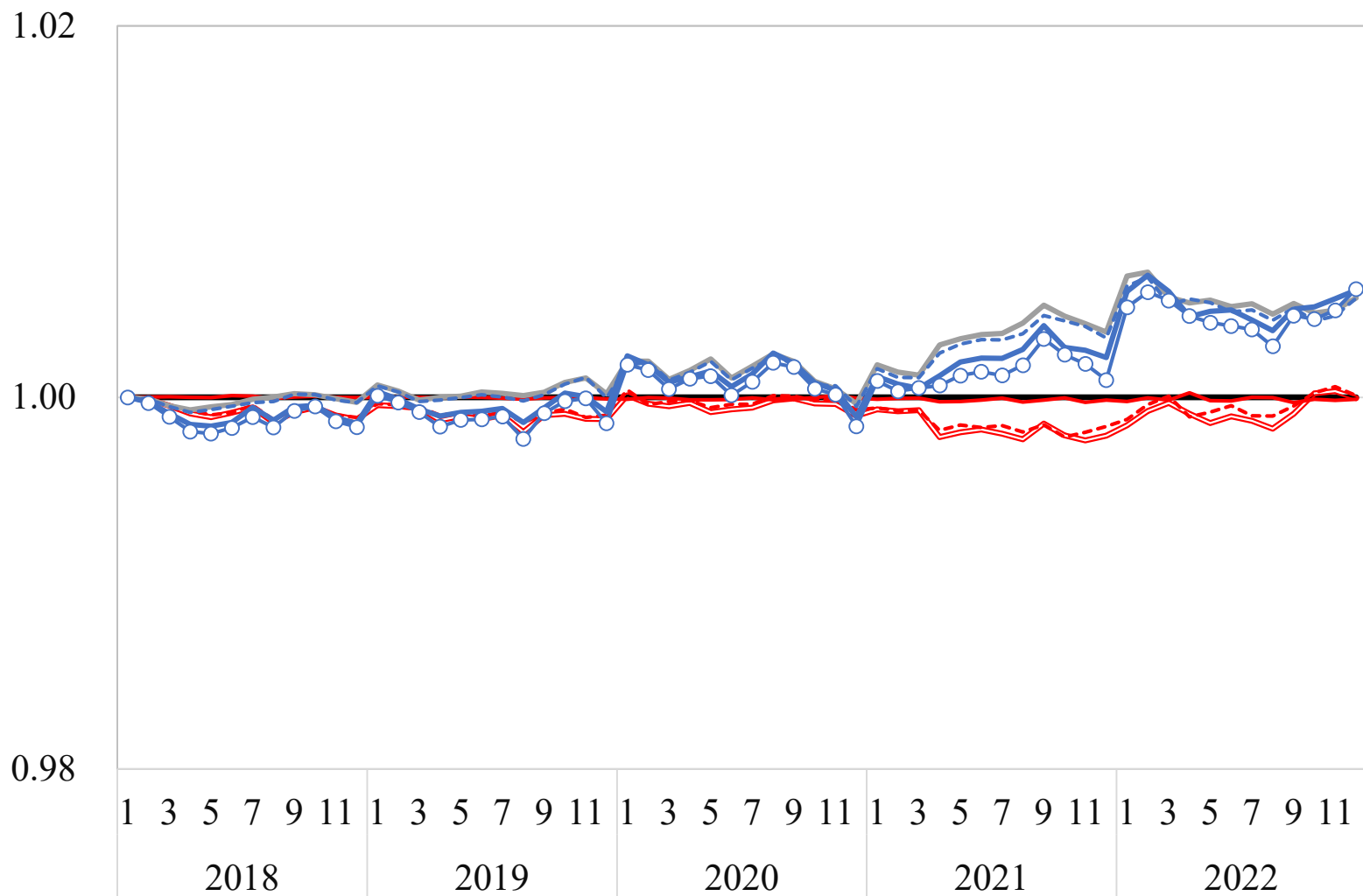


Consumption

No.	Age (6 category)	Income (5)	Region (8)	# of Price Indexes
000	0	0	0	1
001	0	0	1	8
010	0	1	0	5
011	0	1	1	40
100	1	0	0	6
101	1	0	1	48
110	1	1	0	30
111	1	1	1	240

Back to log variance

# Ratio of Real to Nominal :Gini coefficient



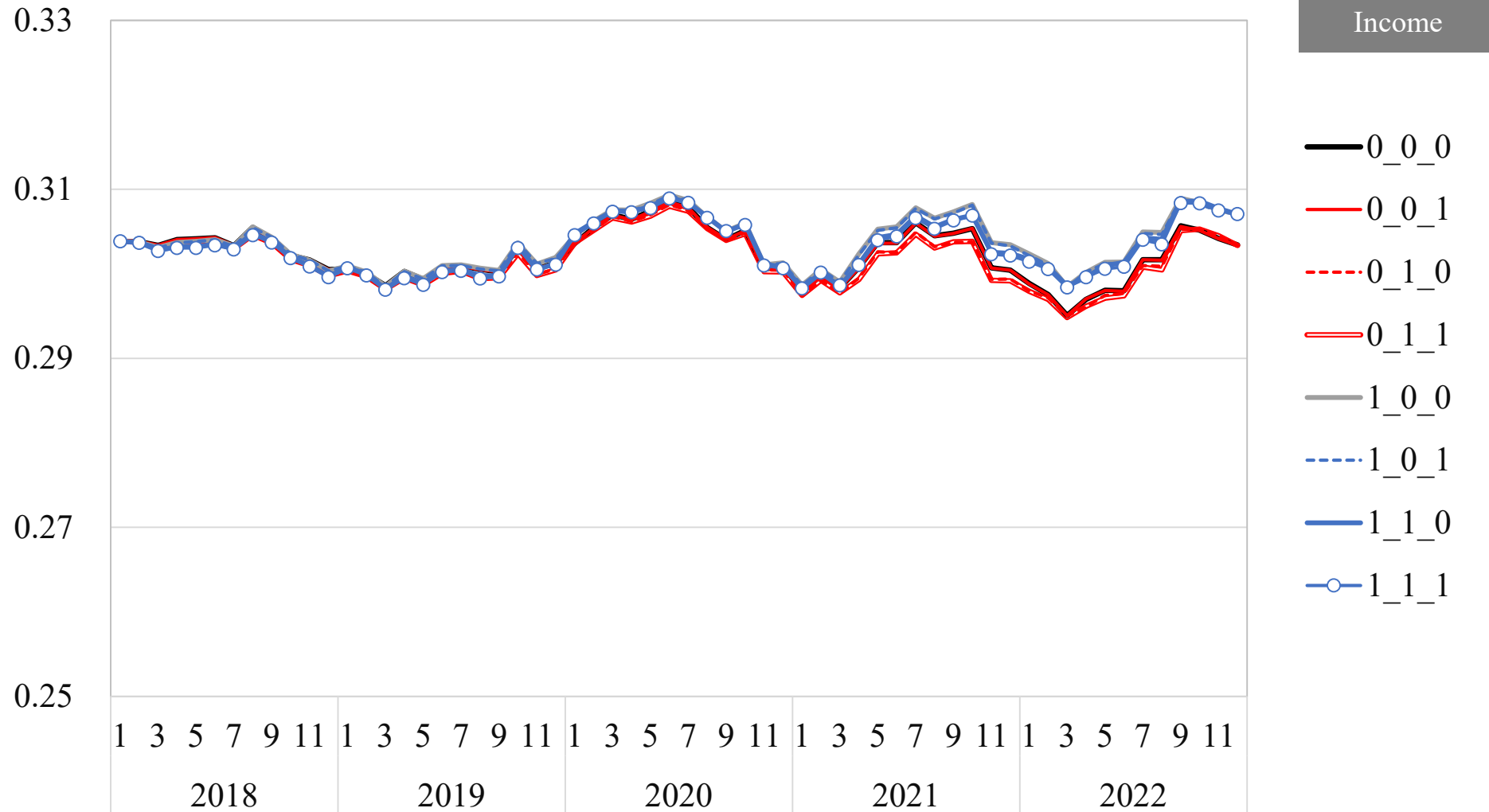
Consumption

- 0\_0\_0
- 0\_0\_1
- - - 0\_1\_0
- 0\_1\_1
- 1\_0\_0
- - - 1\_0\_1
- 1\_1\_0
- 1\_1\_1

No.	Age (6 category)	Income (5)	Region (8)	# of Price Indexes
000	0	0	0	1
001	0	0	1	8
010	0	1	0	5
011	0	1	1	40
100	1	0	0	6
101	1	0	1	48
110	1	1	0	30
111	1	1	1	240

Back to log variance

# Inequality and Price Index (Fisher): Gini coefficient (income)

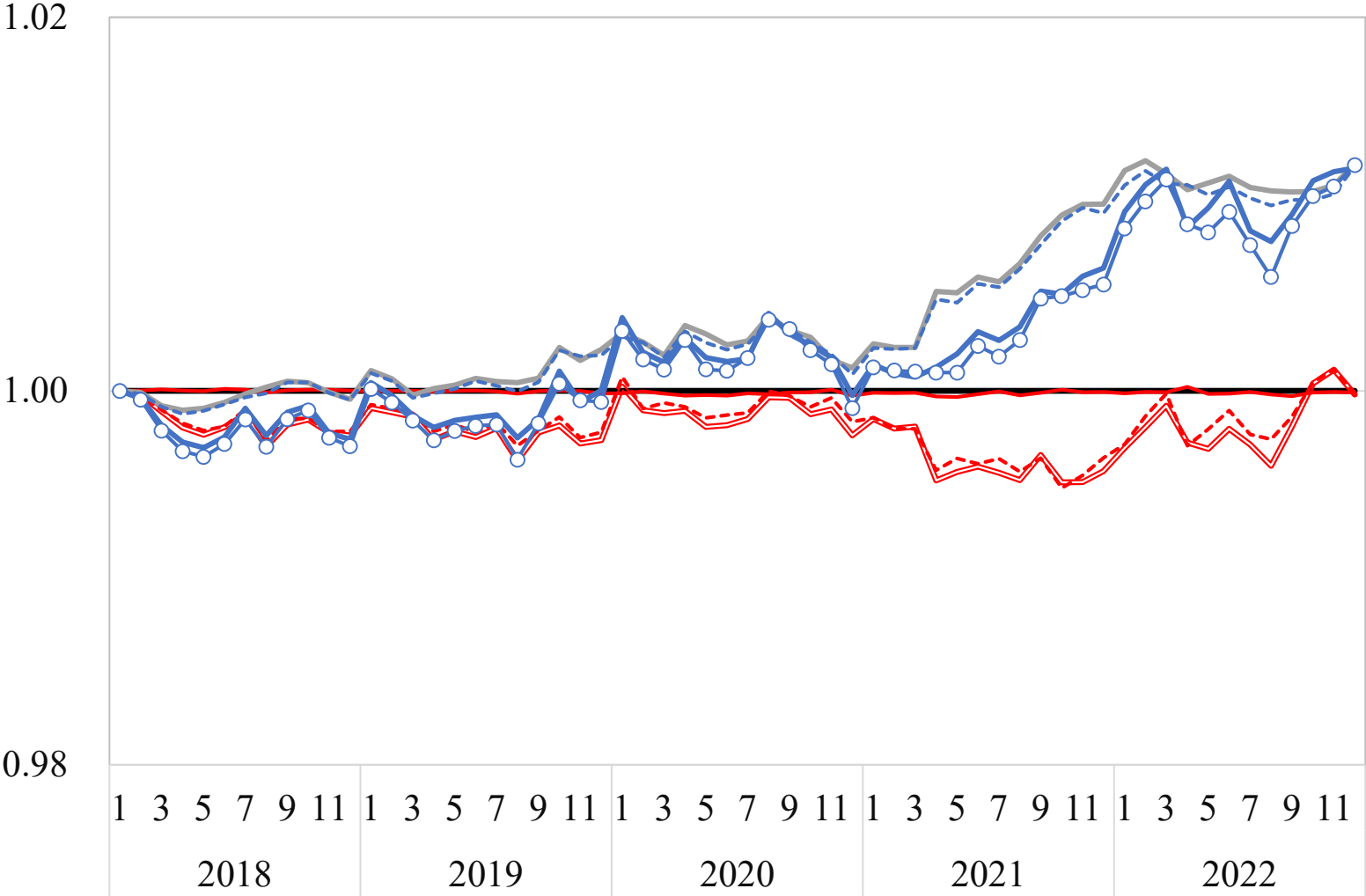


No.	Age (6 category)	Income (5)	Region (8)	# of Price Indexes
000	0	0	0	1
001	0	0	1	8
010	0	1	0	5
011	0	1	1	40
100	1	0	0	6
101	1	0	1	48
110	1	1	0	30
111	1	1	1	240

[Back to log variance](#)



# Ratio of Real to Nominal :Gini coefficient (income)



Income

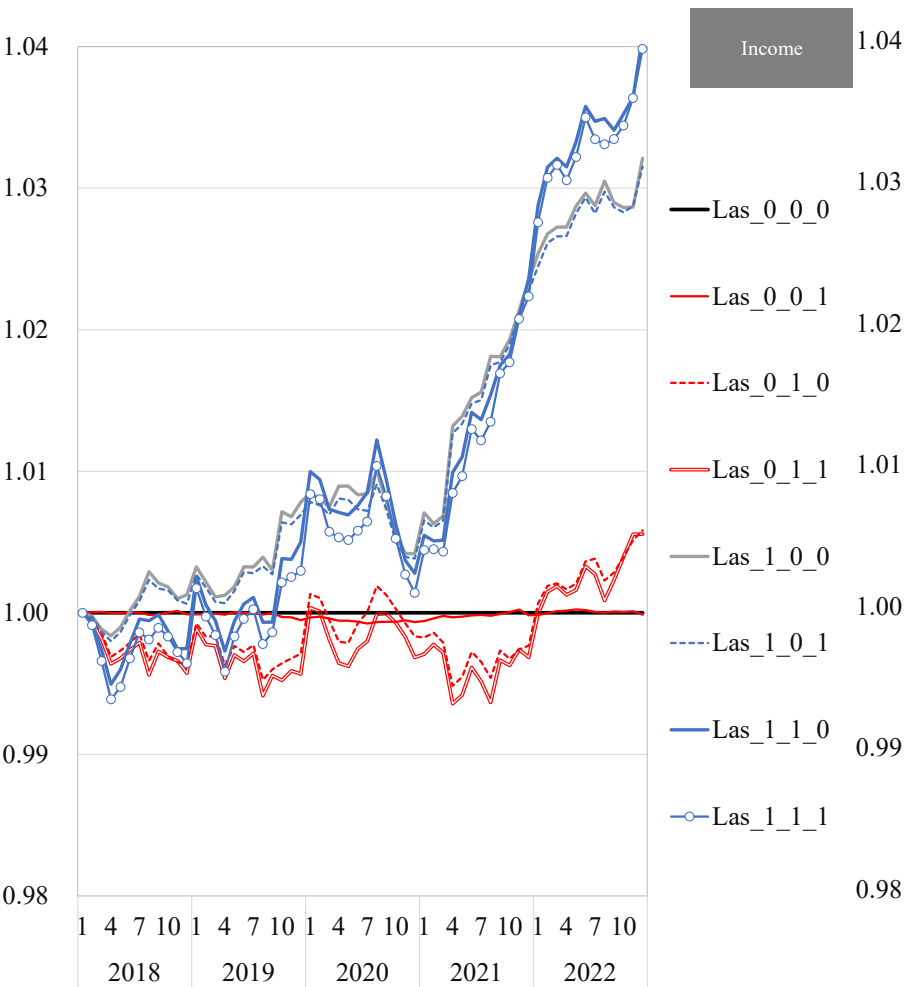
- 0\_0\_0
- 0\_0\_1
- - - 0\_1\_0
- 0\_1\_1
- 1\_0\_0
- - - 1\_0\_1
- 1\_1\_0
- 1\_1\_1

No.	Age (6 category)	Income (5)	Region (8)	# of Price Indexes
000	0	0	0	1
001	0	0	1	8
010	0	1	0	5
011	0	1	1	40
100	1	0	0	6
101	1	0	1	48
110	1	1	0	30
111	1	1	1	240

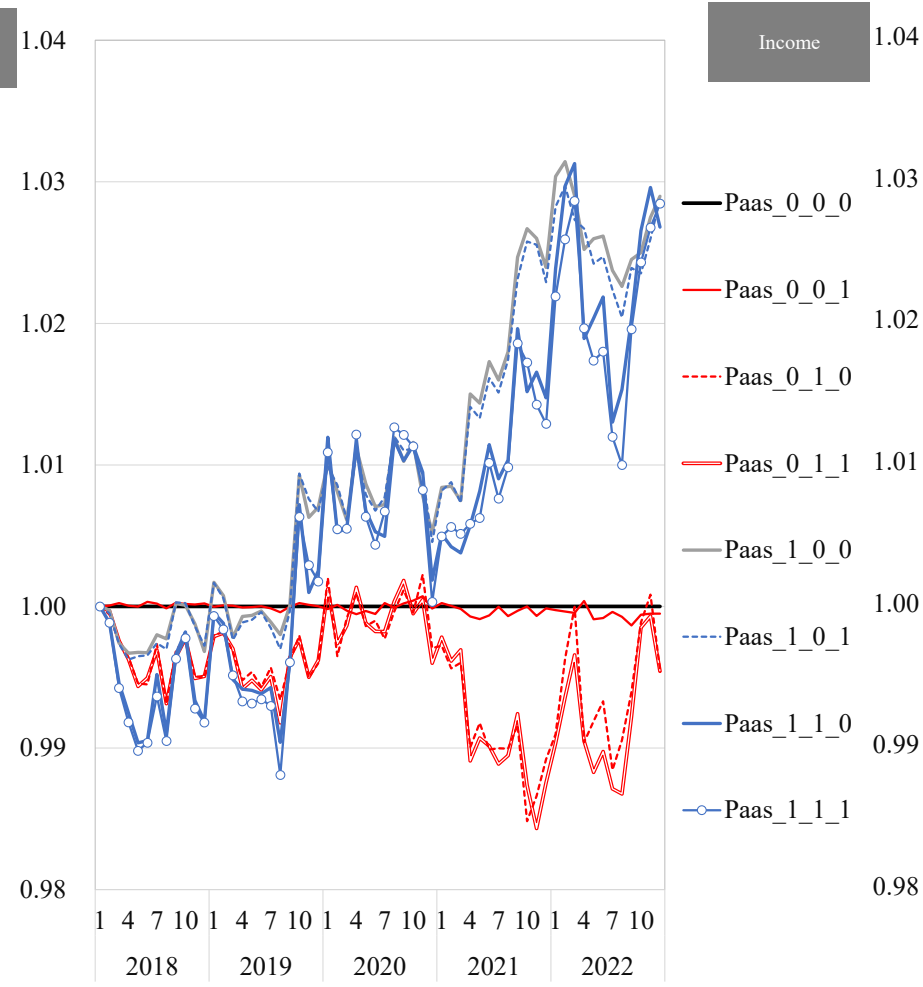
Back to log variance

# Ratio of Real to Nominal: $\text{Var}(\ln(\text{income}))$

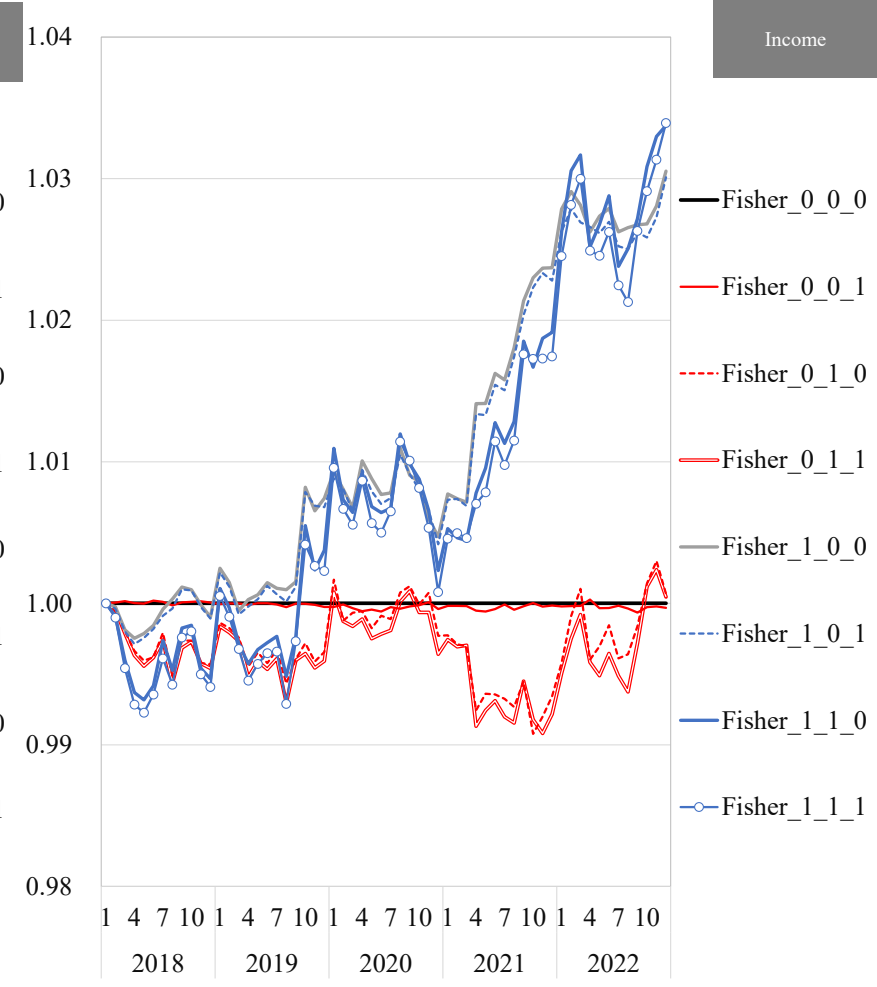
## Deflated by Laspeyres



## Deflated by Paasche

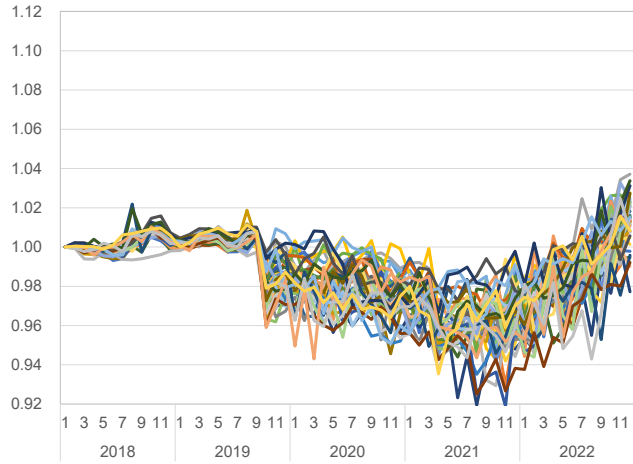


## Deflated by Fisher

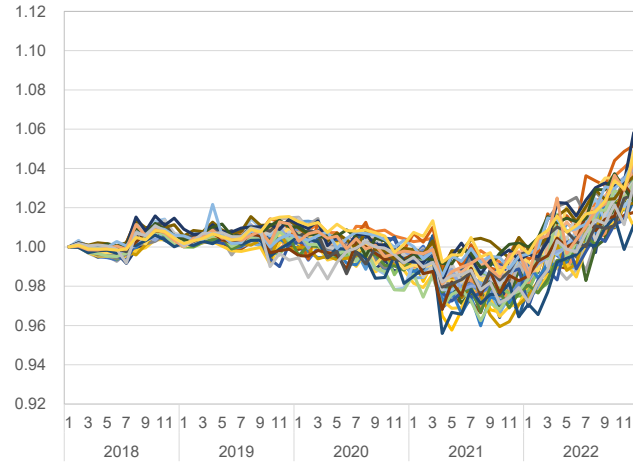


# Price Index 111 for each age category

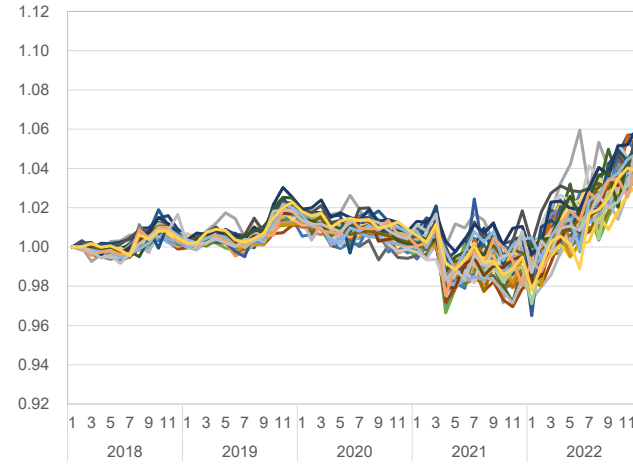
## under 40



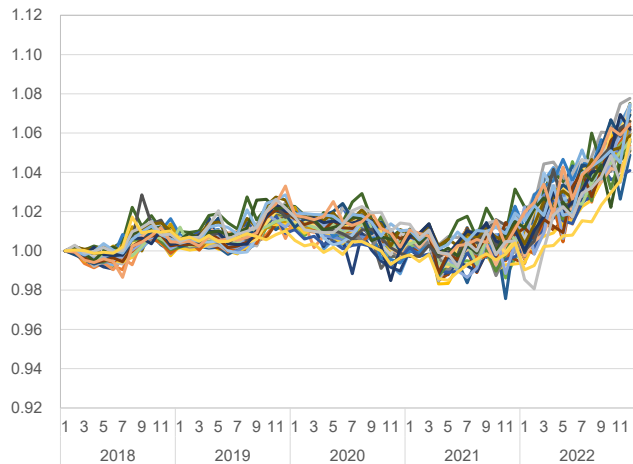
## 40-49



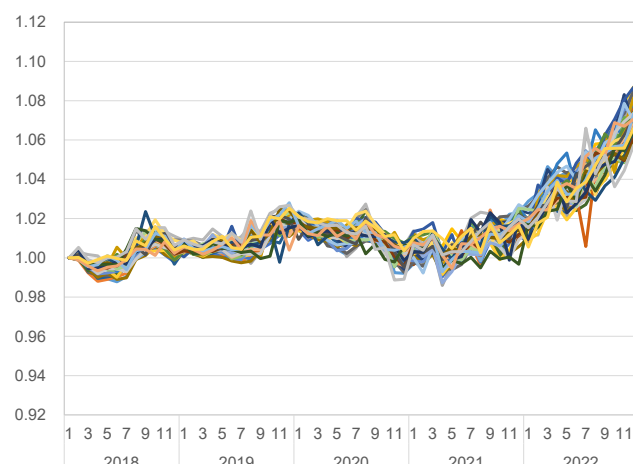
## 50-59



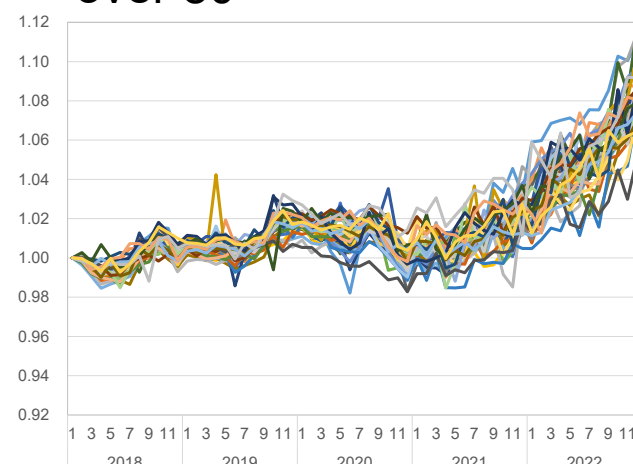
## 60-69



## 70-79



## over 80



- 50\_I\_H&T
- 50\_I\_H
- 50\_I\_K
- 50\_I\_L
- 50\_I\_S
- 50\_II\_H&T
- 50\_II\_H
- 50\_II\_K
- 50\_II\_S
- 50\_III\_H&T
- 50\_III\_H
- 50\_III\_K
- 50\_III\_S
- 50\_IV\_H&T
- 50\_IV\_H
- 50\_IV\_K
- 50\_IV\_S
- 50\_V\_H&T
- 50\_V\_H
- 50\_V\_K
- 50\_V\_S
- 50\_I\_K
- 50\_I\_T
- 50\_I\_C
- 50\_I\_K&O
- 50\_II\_K
- 50\_II\_T
- 50\_II\_C
- 50\_II\_K&O
- 50\_III\_K
- 50\_III\_T
- 50\_III\_C
- 50\_III\_K&O
- 50\_IV\_K
- 50\_IV\_T
- 50\_IV\_C
- 50\_IV\_K&O
- 50\_V\_K
- 50\_V\_T
- 50\_V\_C
- 50\_V\_K&O

- 80\_I\_H&T
- 80\_I\_H
- 80\_I\_K
- 80\_I\_C
- 80\_I\_S
- 80\_II\_H&T
- 80\_II\_H
- 80\_II\_K
- 80\_II\_S
- 80\_III\_H&T
- 80\_III\_H
- 80\_III\_K
- 80\_III\_S
- 80\_IV\_H&T
- 80\_IV\_H
- 80\_IV\_K
- 80\_IV\_S
- 80\_V\_H&T
- 80\_V\_H
- 80\_V\_K
- 80\_V\_S
- 80\_I\_K
- 80\_I\_T
- 80\_I\_C
- 80\_I\_K&O
- 80\_II\_K
- 80\_II\_T
- 80\_II\_C
- 80\_II\_K&O
- 80\_III\_K
- 80\_III\_T
- 80\_III\_C
- 80\_III\_K&O
- 80\_IV\_K
- 80\_IV\_T
- 80\_IV\_C
- 80\_IV\_K&O
- 80\_V\_K
- 80\_V\_T
- 80\_V\_C
- 80\_V\_K&O

# Previous studies on inflation disparities

By age	<p>✓ Higher inflation rate for older households compared to younger households.</p> <p><a href="#">Jaravel &amp; O'Connell (2020, J. Pub. Econ.)</a></p>
By income	<p>✓ Most recent studies indicate that the lower a household's income is, the higher the inflation rate tends to be.</p> <p><a href="#">Jaravel (2019, QJE)</a> , <a href="#">Wimer &amp; Collyer &amp; Jaravel (2019, Policy Brief, Columbia Univ.)</a> , <a href="#">Kaplan &amp; Schulhofer-Wohl (2017, J. Mon. Econ.)</a>, <a href="#">Cavallo (2020, NBER WP)</a></p>
By region	<p>✓ Several studies indicate that <b>not</b> utilizing regional price information leads to an <b>overestimation</b> of inequality.</p> <p><a href="#">Moretti (2013, Applied Econ.)</a>, <a href="#">Slensnick (2002, J. Urban Econ.)</a>, <a href="#">Pendalur (2002, J. Public Econ.)</a>, <a href="#">Morikawa (2013, RIETI DP)</a></p>

# Preceding Studies: (1) by age

## **Jaravel & O'Connell (2020, *J. Pub. Econ.*)**

- Focusing on Inflation during the COVID-19 Lockdown
- Calculating Household-Specific Inflation Rates from UK Scanner Data
- Reporting a 0.20% higher inflation rate in 2020 for older households (56 years and above) compared to younger households (35 years and below).

# Preceding Studies: (2) by income

## **Jaravel (2021, *Annu. R. Econ.*)**

From 2004 to 2015, the average annual Tornqvist inflation has exhibited a nearly linear decrease across income deciles. (D1-D10 is 0.346 percentage points.)

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

- Re-estimating poverty and income inequality from 2004 to 2018.
- An additional 3.2 million people are classified as living in poverty.

## **Jaravel (2019, *QJE*)**

Annual inflation rates for those at the bottom of the income distribution are substantially higher (0.44pp) than for those at the top of the income distribution.

## **Kaplan & Schulhofer-Wohl (2017, *J. Mon. Econ.*)**

Using scanner data (Nielsen). Over a cumulative period of 9 years from 2004, households with incomes below \$20,000 have inflation rates 8-9% higher compared to those with incomes above \$100,000.

## **Cavallo (2020, *NBER WP*)**

Obtaining expenditure data during the COVID-19 period from credit and debit card information and recalculating the Consumer Price Index (CPI).

Comparing inflation by income quintile (as of May 2020, low-income: 1.12%, high-income: 0.57%).

# Preceding Studies: (3) by region

## **Moretti (2013, *Applied Econ.*)**

- Original estimate of CPI taking into account differences in housing prices by city
- Nominal wage premium for college graduates (+20% in 2000) declined to +14%

## **Slensnick (2002, *J. Urban Econ.*)**

- Evaluate the measurement of real spending disparities with regional price indexes
- (Use of a common national index) leads to overestimation of the poverty rate

## **Pendalur (2002, *J. Public Econ.*)**

- Use of regional price indexes would change the trends in the Gini coefficient

## **Morikawa (2013, *RIETI DP*)**

- Disparity in the minimum wages
- Real wage disparity is smaller than nominal wage disparity when using prefecture-specific price indexes