Inflation expectations in Japan: Forecast revision and forecast trend

Weiyang Zhai (Toyama University)
Yushi Yoshida (Shiga University)

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Objectives of this research

- How is expected inflation formed in Japan?
  - During the zero-inflation period
  - In the post-COVID-19 period with high inflation

- Is inflation expectation rational?
  - Forecast error regression (FIRE: Full Information Rational Expectation)
    - No variables should have explanatory power

  - Coibion and Gorodnichenko (2015)'s information rigidity model
    - Forecast revision variable may have a significant effect

- We apply a modified CG model to the Japanese data.

Background

- Short summary of the Japanese economy:
  - Japan had experienced low or zero inflation for two decades despite the unprecedented monetary policy easing.
  - Only after COVID-19, we observed inflation in Japan to rise gradually.
  - The BOJ shifted from zero interest-rate policy in March 2024
- One of the main topics of our previous research is exchange rate pass-through.
  - Our previous research yielded many important findings.
  - Exchange rate pass-through on the core-CPI is only 2 percent.
    - Sasaki, Yoshida, Otsubo, 2022, JIMF.
  - An exchange rate change significantly affects the consumer price only when they are driven by a negative demand shock.
    - Yoshida and Zhai, 2025, JIMF.
- We came to understand that we should pay attention to the formation of inflation expectations to understand the ERPT.

The summary of this study

- Objectives:
  - We estimate inflation expectations are formed in Japan, from 1993:Q4 to 2025:Q1
  - We use the modified forecast revision CG model.

- Main Results:

① We find that a new ‘forecast revision’ term is useful in investigating inflation forecasts.

② People in Japan forecast inflation under information rigidity and form their expectations that deviate from the rational expectations in the post-COVID-19.

③ Under the zero-inflation regime in Japan, people formed their forecasts in accordance with rational expectations, and there was no information frictions.

Literature Review

Information rigidity

$$\pi_{t+h} - \bar{E}_t[\pi_{t+h}] = \frac{\lambda}{1-\lambda}(\bar{E}_t[\pi_{t+h}] - \bar{E}_{t-1}[\pi_{t+h}])$$

Full Information Rational expectation: $\lambda = 0$

Expectations adjust sluggishly: $\lambda > 0$

$$\pi_{t+h} - \bar{E}_t[\pi_{t+h}] = \frac{1-G}{G}(\bar{E}_t[\pi_{t+h}] - \bar{E}_{t-1}[\pi_{t+h}]) + v_{t+h,t}$$

Full Information Rational expectation: G= 1

Noisy information: G < 1

Sticky-information Model

Noisy-information Model

Imperfect expectations

CG Model
Coibion & Gorodnichenko (2015 AER)

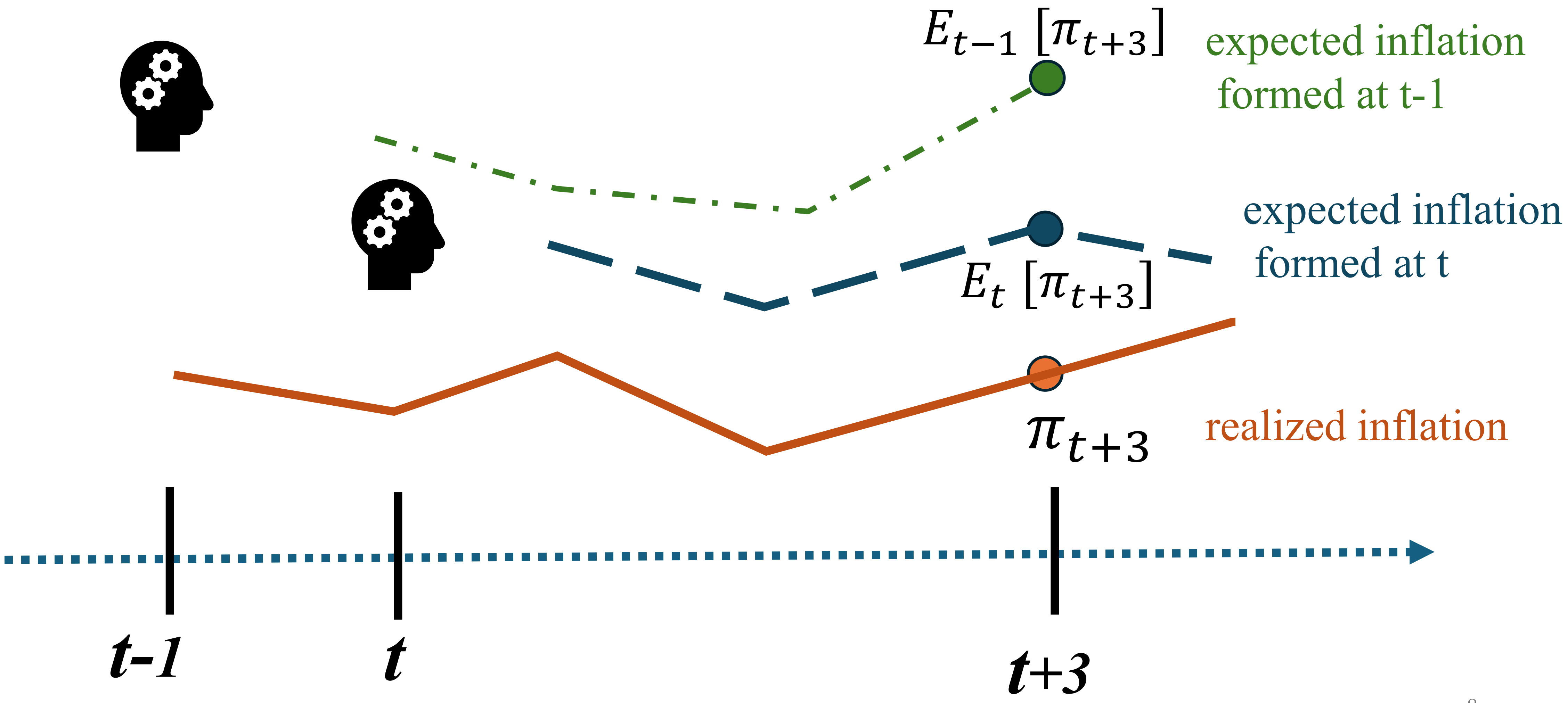
- Olivier Coibion and Yuriy Gorodnichenko, 2015, Information Rigidity and the Expectation Formation Process: A Simple Framework and New Facts, American Economic Review, 105(8)

- Two theoretical models with 'information rigidity' lead to the same equation for any macroeconomic variable 'x'. These two models retain rational expectations, but not full information.
  - Sticky-information Model
    - Mankiw and Reis (2002), Reis (2006)
  - Noisy-information Model
    - Lucas (1972), Kydland and Prescott (1982)

$$x_{t+h} - \bar{E}_t[x_{t+h}] = \alpha + \beta\{\bar{E}_t[x_{t+h}] - \bar{E}_{t-1}[x_{t+h}]\} + u_t$$

CG Model (quarterly SPF inflation forecasts)

Coibion & Gorodnichenko (2015 AER)



CG Model (quarterly SPF inflation forecasts)
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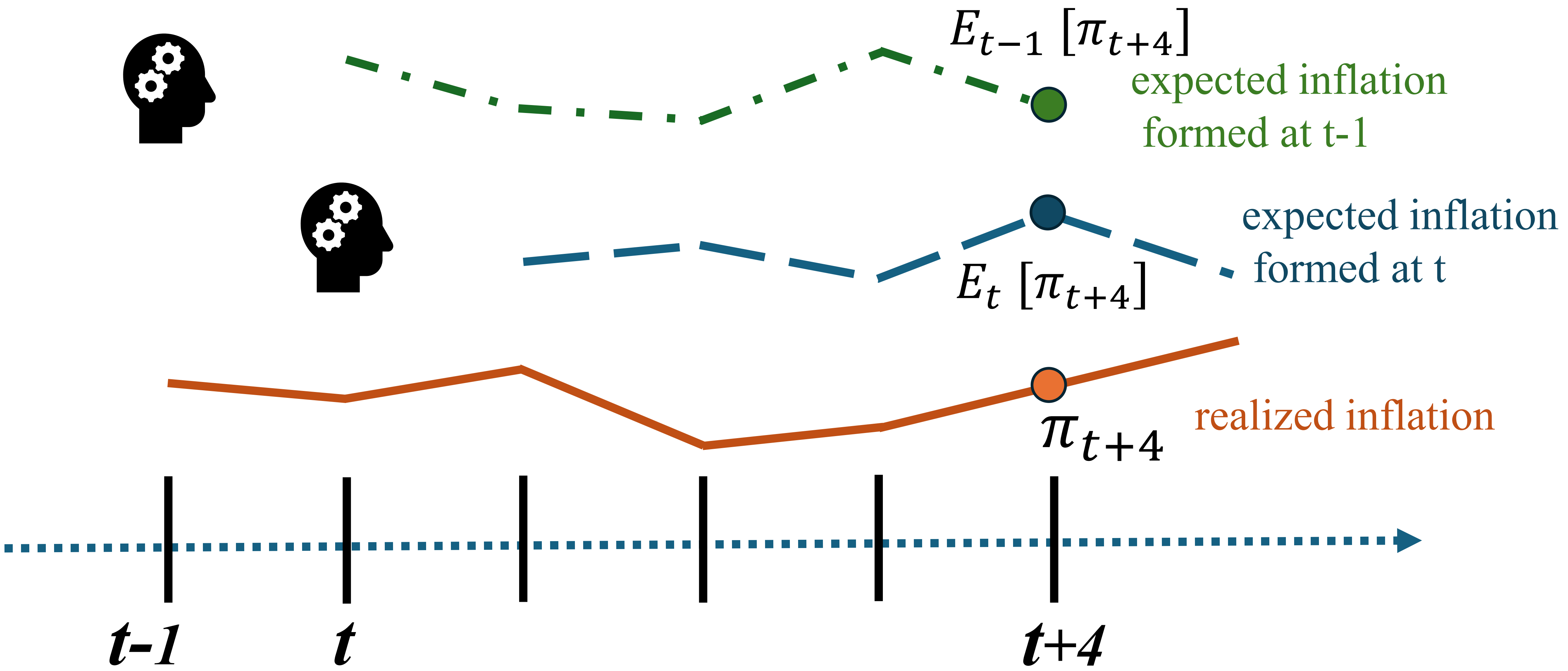
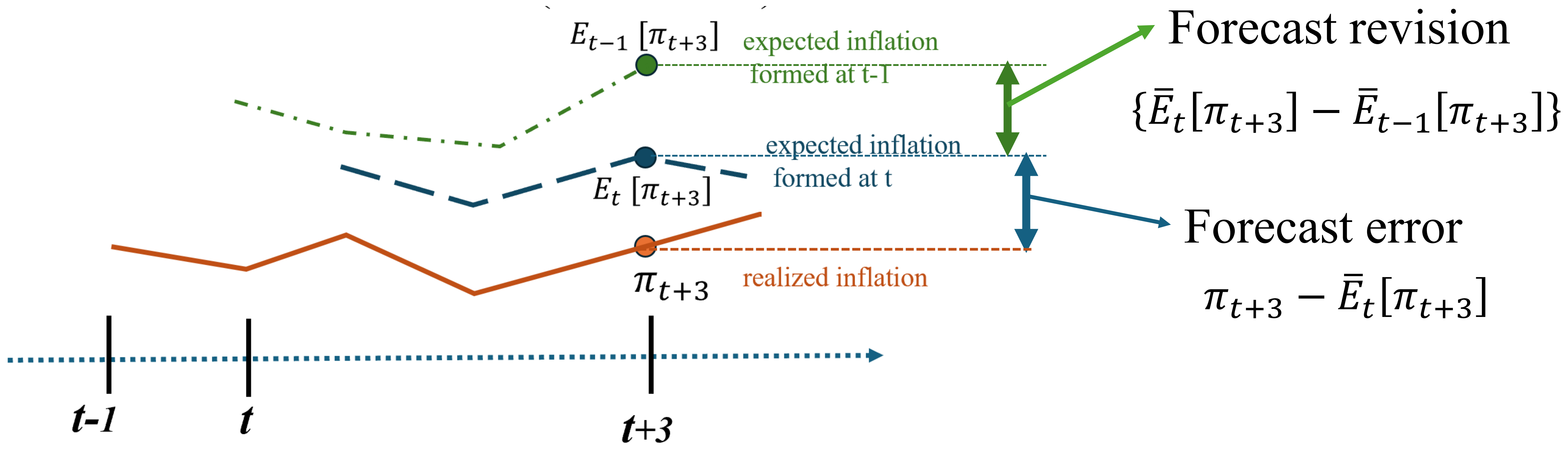


CG Model



Forecast error$_t$ = α + K ▪ Forecast revision$_t$ + u$_t$

$$\pi_{t+3} - \bar{E}_t[\pi_{t+3}] = \alpha + K_{CG}\{\bar{E}_t[\pi_{t+3}] - \bar{E}_{t-1}[\pi_{t+3}]\} + u_t$$

CG Model

- Coibion and Gorodnichenko (2015) examined inflation and unemployment expectations in the US from 1969 to 2014 using the following model:

$$\textbf{Forecast error}_t = \alpha + K_{CG} \cdot \textbf{Forecast revision}_t + u_t$$

$$\pi_{t+3} - \bar{E}_t[\pi_{t+3}] = \alpha + K_{CG}\{\bar{E}_t[\pi_{t+3}] - \bar{E}_{t-1}[\pi_{t+3}]\} + u_t$$

- $K_{CG} = 0$ (forecast errors should be random): Full-information Rational expectations
- $K_{CG} > 0$ (consistent with information rigidity): Underreaction (too low forecast when upward revision)
- $K_{CG} < 0$: Overreaction (too high forecast when upward revision)

- **NO addition control variable** should not have statistical significance if FIRE (full-information rational expectation) holds.

CG Model (Table 1): The results are consistent with information friction models

	Additional control: z_{t-1}				
Forecast error $\pi_{t+3,t} - F_t \pi_{t+3,t}$	None (1)	Inflation (2)	Average quarterly 3-month Tbill rate (3)	Quarterly change in the log of the oil price (4)	Average unemployment rate (5)
Panel B. $\pi_{t+3,t} - F_t\pi_{t+3,t} = c + \beta(F_t\pi_{t+3,t} - F_{t-1}\pi_{t+3,t}) + \delta z_{t-1} + error_t$					
Constant	0.002	−0.074	0.151	−0.021	1.134**
	(0.144)	(0.174)	(0.175)	(0.146)	(0.546)
$F_t\pi_{t+3,t} - F_{t-1}\pi_{t+3,t}$	1.193**	1.141**	1.196**	1.125**	1.062**
	(0.497)	(0.458)	(0.504)	(0.499)	(0.465)
Additional control: z_{t-1}		0.021	−0.029	0.576	−0.178**
		(0.050)	(0.031)	(0.608)	(0.076)
Observations	173	173	173	173	173
R^2	0.195	0.197	0.201	0.200	0.249

Reproduced from Coibion and Gorodnichenko (2015), American Economic Review

CG Model

- The estimated coefficients of 'forecast revision' are always positive and statistically significant, indicating the result is consistent with the information rigidity model.

- Through columns (2) to (5), additional control variables were not statistically significant, and they imply that full-information rational expectations (FIRE) were not violated. However,

- "In the case of unemployment, however, there is additional predictive power even after controlling for forecast revisions, although the coefficient on the unemployment rate is cut by approximately 40 percent. This finding suggests that deviations from FIRE may exist above and beyond those captured by simple models of information rigidities and further exploration of these deviations is a fruitful avenue for future research." (p.2655)

Literature Review

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Data

Inflation Forecasts

Composite Index of Inflation Expectations (CIE)

- Composite Index of Inflation Expectations (CIE), BOJ
  - Osada and Nakazawa (2024)
  - Forecast horizon: one, two,…, nine, and ten years.
  - Frequency: Quarterly

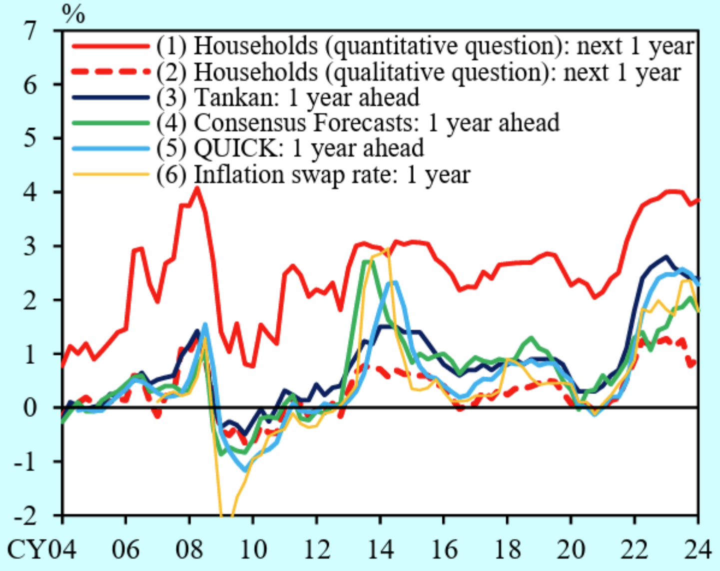
- Constructed the CIE, using the six measures of inflation expectations:
  - two measures for households (qualitative and quantitative questions, "The Opinion Survey on the General Public's Views and Behavior"),
  - one measure for firms (Tankan),
  - three measures for experts (Consensus Forecasts, QUICK, and inflation swap rates)

- The CIE index is based on the principal component and forecasting power, constructed by Osada and Nakazawa (2024)
- Build a time series model and use estimation to interpolate values for forecast horizons that were not available. ※For example, for consumers, there are only "Outlook for Price Levels One Year" and "Outlook for Price Levels over the Next Five Years"

Composite Index of Inflation Expectations (CIE)

- Households (two):
  - Qualitative and quantitative questions, “The Opinion Survey on the General Public‘s Views and Behavior” (1) and (2)
- Firms (one):
  - Tankan (3)
- Experts (three):
  - Consensus Forecasts (4), QUICK (5), and inflation swap rates (6)

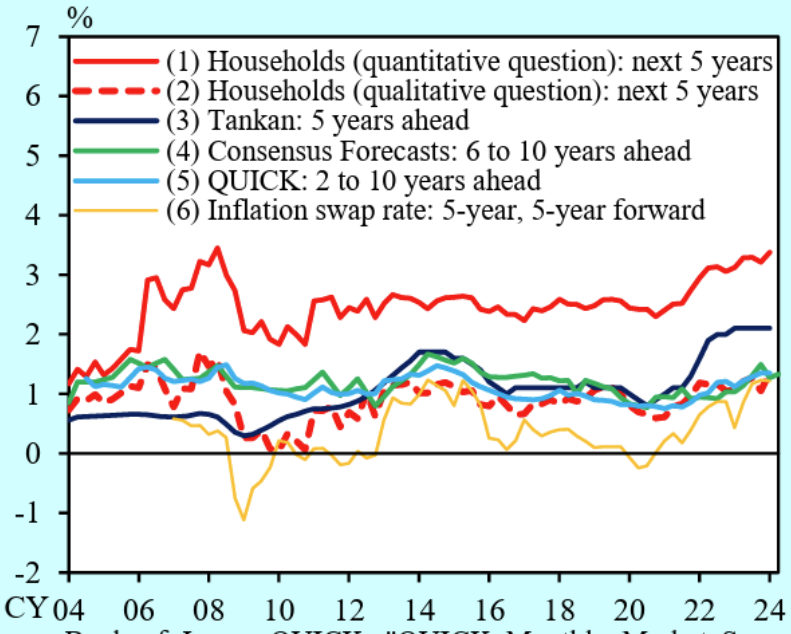
[Chart 2] Measures of Inflation Expectations: Short-term



Note: Figures for Measure (4) (based on the Consensus Forecasts) are the average of forecasts for 3 to 5 quarters ahead.

Sources: Bank of Japan; QUICK, "QUICK Monthly Market Survey <Bonds>"; Consensus Economics Inc., "Consensus Forecasts"; Bloomberg.

[Chart 3] Measures of Inflation Expectation: Medium- to Long-term



Sources: Bank of Japan; QUICK, "QUICK Monthly Market Survey <Bonds>"; Consensus Economics Inc., "Consensus Forecasts"; Bloomberg.

Reproduced from Osada and Nakazawa (2024), Bank of Japan Review

バックデータ/**Background Dataset**

Quarter	[Chart 8] Principal Component-Based Composite Index of Inflation Expectations, by Forecast Horizon									
	1 year ahead	2 years ahead	3 years ahead	4 years ahead	5 years ahead	6 years ahead	7 years ahead	8 years ahead	9 years ahead	10 years ahead
2019/7/1	0.4	0.6	0.6	0.7	0.8	0.8	0.8	0.8	0.8	0.9
2019/10/1	0.3	0.5	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8
2020/1/1	0.1	0.3	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.7
2020/4/1	0.0	0.2	0.4	0.5	0.5	0.6	0.6	0.6	0.7	0.7
2020/7/1	0.0	0.2	0.3	0.4	0.5	0.5	0.6	0.6	0.6	0.6
2020/10/1	0.0	0.2	0.3	0.4	0.5	0.5	0.6	0.6	0.6	0.6
2021/1/1	0.0	0.3	0.4	0.5	0.6	0.6	0.6	0.7	0.7	0.7
2021/4/1	0.2	0.4	0.5	0.6	0.7	0.7	0.7	0.7	0.8	0.8
2021/7/1	0.3	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8
2021/10/1	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	0.9
2022/1/1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1
2022/4/1	1.5	1.3	1.2	1.1	1.1	1.1	1.1	1.2	1.2	1.2
2022/7/1	1.7	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
2022/10/1	1.8	1.4	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
2023/1/1	1.8	1.4	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2
2023/4/1	1.8	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
2023/7/1	1.8	1.5	1.4	1.4	1.3	1.4	1.4	1.4	1.4	1.4
2023/10/1	1.7	1.5	1.4	1.3	1.3	1.4	1.4	1.4	1.4	1.4
2024/1/1	1.7	1.5	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5

Reproduced from CIE Dataset, Osada and Nakazawa (2024), Bank of Japan Review

The crucial difference in the data structure: US data (SPF) versus JPN data

US	1-month ahead	2-month ahead	3-month ahead	4-month ahead
2000Q1				
2000Q2				
2000Q3				○
2000Q4			○	

These are forecasts for the same quarter, 2001Q3

JPN	1-year ahdad	2-year ahead	3-year ahead	4-year ahead
1999Q4		○		
2000Q1				
2000Q2				
2000Q3				
2000Q4	○			

These are forecasts for the same quarter, 2001Q4

Modified empirical model

Changing the forecast horizon

- CG Model (forecast horizon: three quaters):

Forecast error$_t$ = $\alpha + K_{CG}$ ▪ Forecast revision$_t$ + u_t

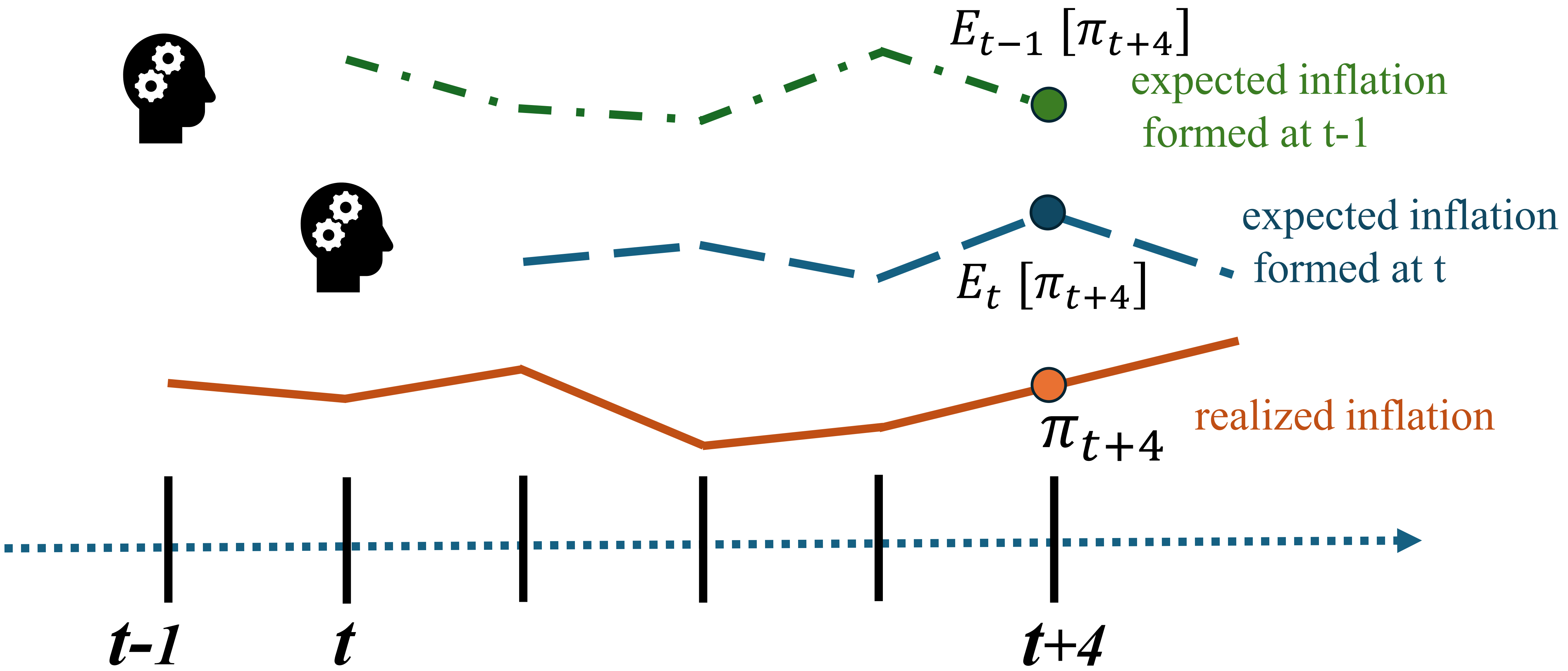
$$\pi_{t+3} - \bar{E}_t[\pi_{t+3}] = \alpha + K_{CG}\{\bar{E}_t[\pi_{t+3}] - \bar{E}_{t-1}[\pi_{t+3}]\} + u_t$$

- Changing the forecast horizon to be four instead of three quarters:

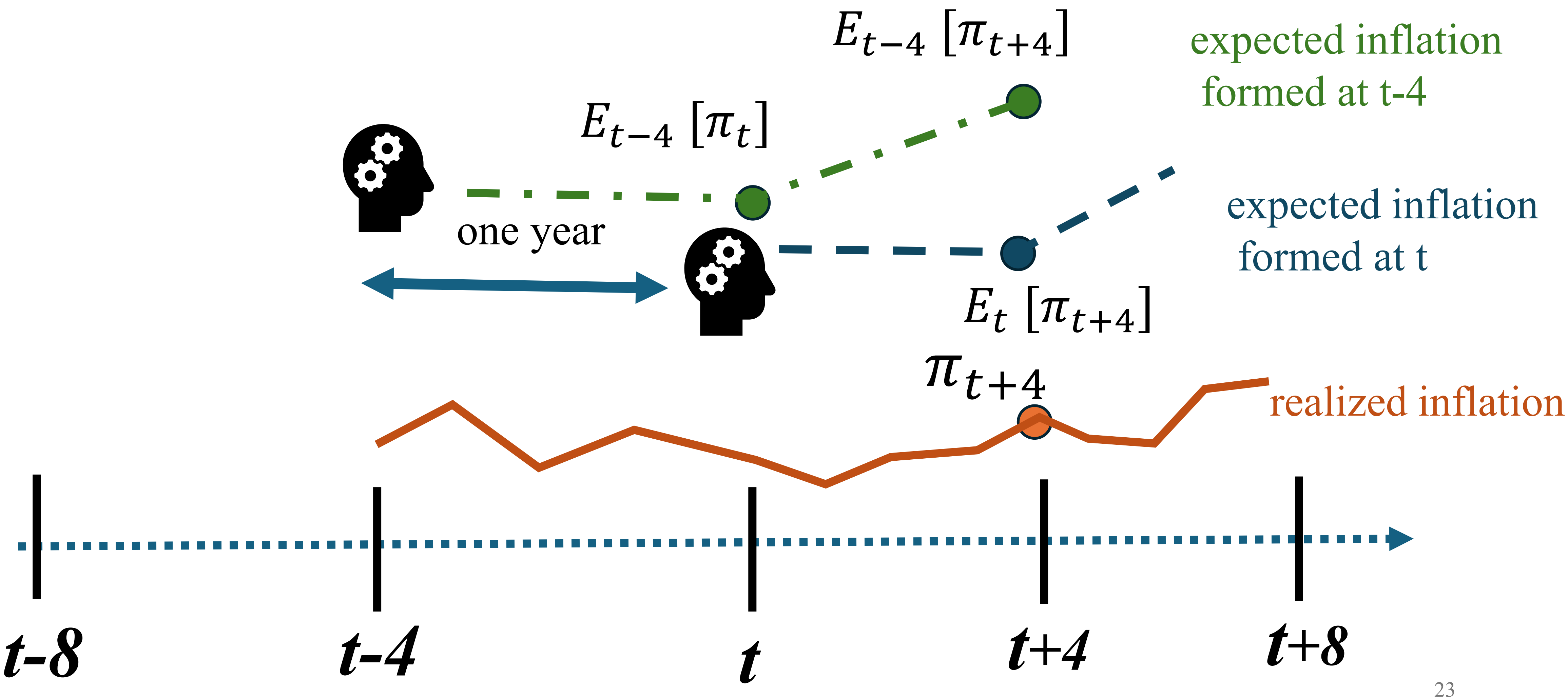
Forecast error$_t$ = $\alpha + K_{CG}$ ▪ Forecast revision$_t$ + u_t

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-1}[\pi_{t+4}]\} + u_t$$

CG Model (quarterly SPF inflation forecasts)
Coibion & Gorodnichenko (2015 AER)



Following CG model:The problems with data availability…(1) forecast revision after one year…



The problems with data availability

(1) Consistent with the CG model. The revision frequency is too long (1 year).

Forecast error$_t$ = α + K_{CG} ▪ forecast revision$_t$ +u$_t$

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t-4+8}]\} + u_t$$

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t+4}]\} + u_t$$

Based on the underlying theoretical model, this specification has no problem.

(2) Modified empirical model. The forecasts are for different quarters.

Forecast error$_t$ = α + K'_{CG} ▪ Modified forecast revision$_t$ +u$_t$

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K'_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t-4+4}]\} + u_t$$

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K'_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t}]\} + u_t$$

The link between the CG model and the modified model

The interpretation of the estimation model (1/3)

- **The CG 4-quarter ahead forecast-error model**

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-1}[\pi_{t+4}]\} + u_t$$

- **Zhai-Yoshida 4-quarter ahead modified forecast-error model**

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K'_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t-4+4}]\} + u_t$$

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K'_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_t]\} + u_t$$

- This model can be represented as a different model with two terms.

Forecast error$_t$ = α + K_1 ▪ Forecast revision$_t$ + K_2 ▪ forecast trend (inflation change forecast)$_t$ + u_t

The interpretation of the estimation model (2/3)

- **Zhai-Yoshida 4-quarter ahead modified forecast-error model**

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K'_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_t]\} + u_t$$

- **Decomposing the modified forecast revision term**

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}]$$
$$= \alpha + K'_{CG}\{\bar{E}_t[\pi_{t+4}] \overbrace{- \bar{E}_{t-4}[\pi_{t+4}] + \bar{E}_{t-4}[\pi_{t+4}]}^{\textbf{Technique: Add and subtract the same term}} - \bar{E}_{t-4}[\pi_t]\} + u_t$$

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}]$$
$$= \alpha + K'_{CG}\underbrace{\boxed{\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t+4}]\}}}_{\text{Same as the CG}} + K'_{CG}\boxed{\{\bar{E}_{t-4}[\pi_{t+4}] - \bar{E}_{t-4}[\pi_t]\}} + u_t$$

Forecast error$_t$ = α + K_1 ▪ Forecast revision$_t$ + K_2 ▪ forecast trend (inflation change forecast)$_t$ + u_t

The interpretation of the estimation model (3/3)

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}]$$
$$= \alpha + K_1\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}\,[\pi_{t+4}]\} + K_2\{\bar{E}_{t-4}\,[\pi_{t+4}] - \bar{E}_{t-4}[\pi_t]\} + u_t$$

Forecast $\text{error}_t = \alpha + K_1 \cdot \text{Forecast revision}_t + K_2 \cdot$ forecast trend (inflation change forecast) $+u_t$

1. The first term coincides with the forecast revision term of the CG model.
2. The second term is the difference in an eight-quarter ahead forecast minus a four-quarter ahead forecast, both forecasted at the same quarter t−4. We coined the latter term as forecast trend. The second term should not systematically affect forecast error. Therefore, K_2 should be zero with FIRE.
3. K_1 and K_2 are not a priori the same. We are imposing a restriction K_1=K_2 with the modified forecast revision term.

Can we come up with new theoretical terms in addition to over/under-reaction, over/under extrapolation,….

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K_1\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t+4}]\} + K_2\{\bar{E}_{t-4}[\pi_{t+4}] - \bar{E}_{t-4}[\pi_t]\} + u_t$$

Forecast $\text{error}_t = \alpha + K_1 \cdot$ Forecast $\text{revision}_t + K_2 \cdot$ Forecast $\text{trend}_t + u_t$

- Rational expectation: $K_1 = 0$ (forecast errors should be random)
- Underreaction: $K_1 > 0$ (too low forecast when upward revision)
- Overreaction: $K_1 < 0$ (too high forecast when upward revision)

Can we come up with new theoretical terms in addition to over/under-reaction, over/under extrapolation,….

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}]$$
$$= \alpha + K_1\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}\,[\pi_{t+4}]\} + K_2\{\bar{E}_{t-4}\,[\pi_{t+4}] - \bar{E}_{t-4}[\pi_t]\} + u_t$$

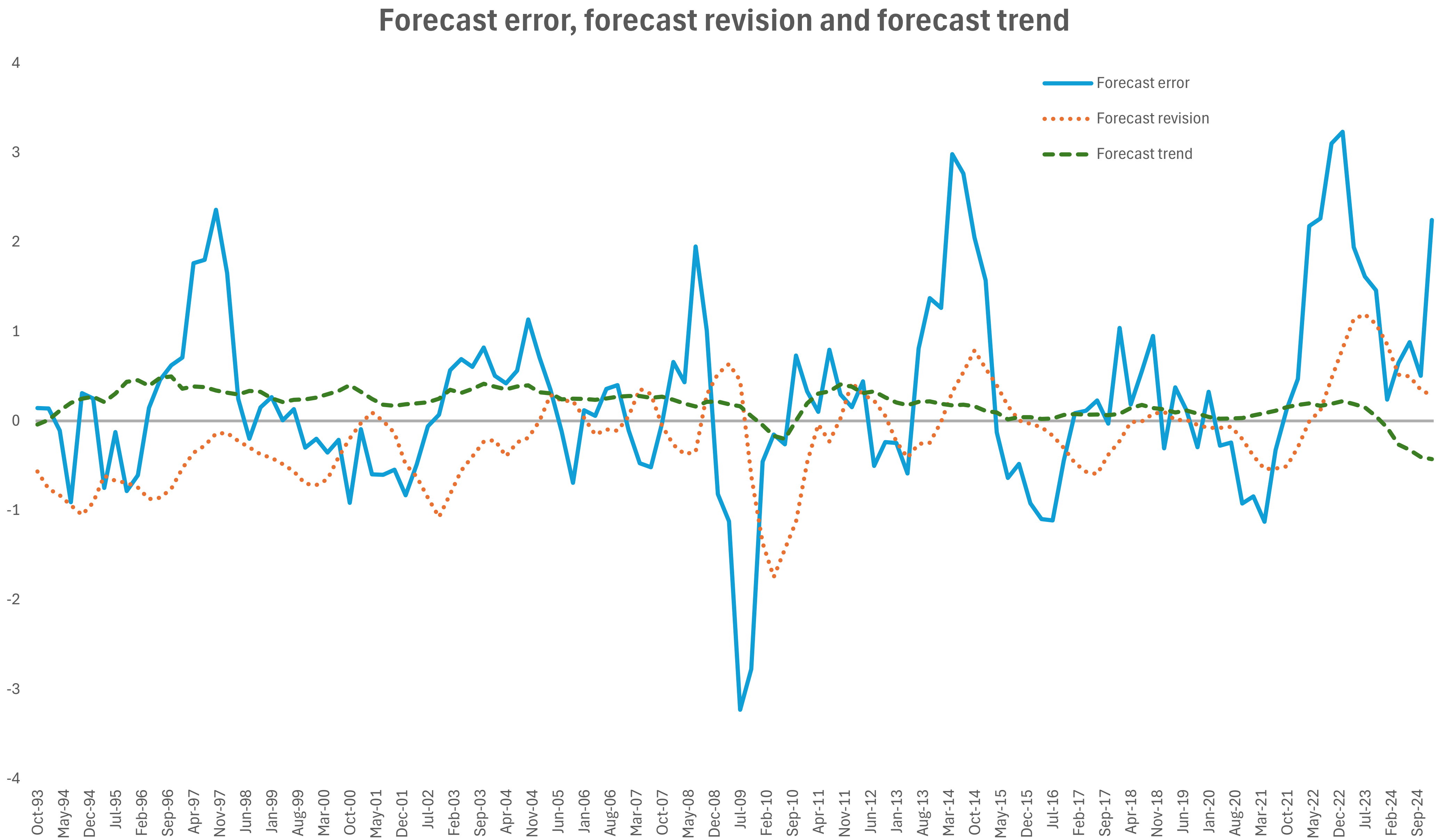
Forecast $\text{error}_t = \alpha + K_1 \cdot \text{Forecast revision}_t + K_2 \cdot \text{Forecast trend}_t + u_t$

- Rational expectation: $K_2 = 0$ (forecast errors should be random)
- Mild trend: $K_2 > 0$ (too low forecast when increasing **forecast trend**)
- Radical trend: $K_2 < 0$ (too high forecast when increasing **forecast trend**)

The test of equal coefficients and interpretations

- We test whether the specification is correct by testing the null hypothesis of equal coefficients of K_1 and K_2 by the classical Wald F-test.

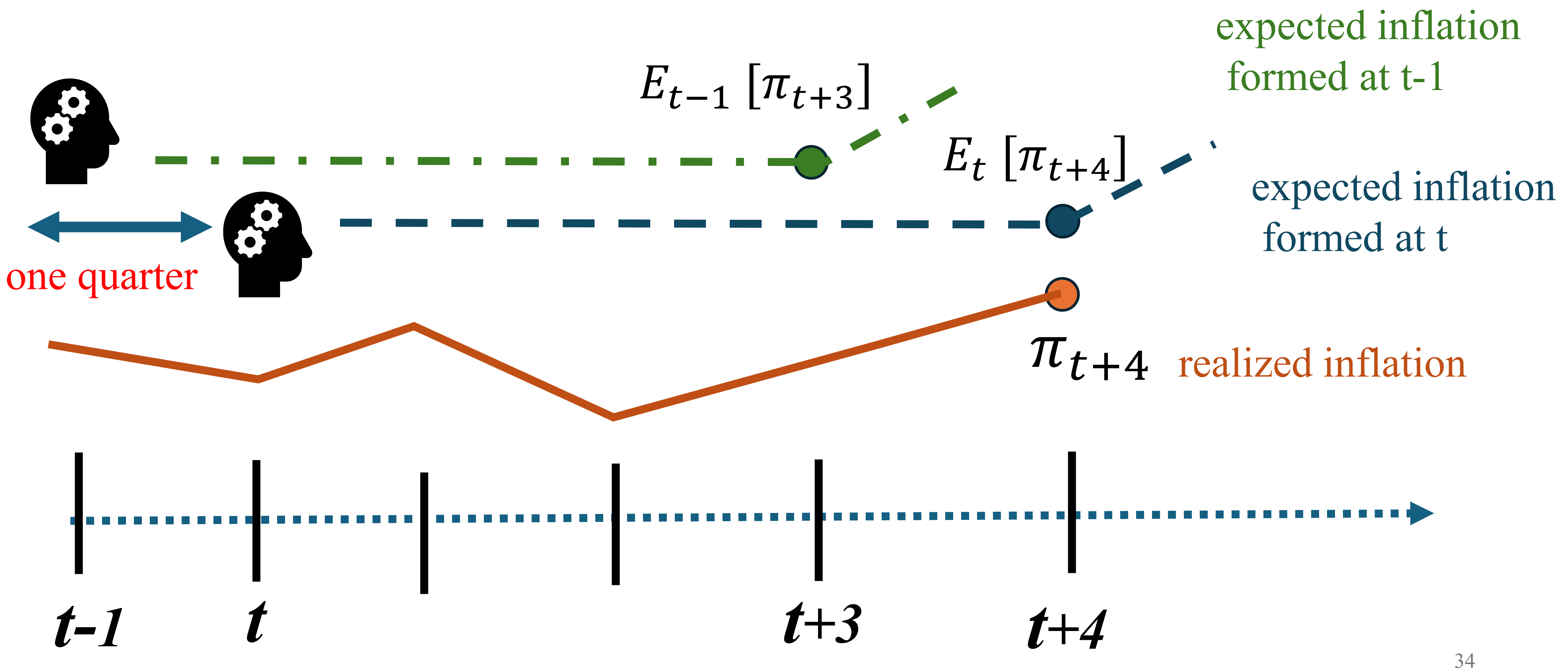
- Two alternative interpretations of the decomposed model:
    a. Test the hypothesis of the original CG forecast revision with control variables. The null hypothesis is $K_2 = 0$.
    b. Test the hypothesis of the modified forecast revision model introduced in this study. The null hypothesis is that $K_1 = K_2$ and $K_2 \neq 0$.



Note: For the data points in 2020:Q4, the realized inflation is that of 2020:Q4, the four-quarter-ahead forecast is made in 1999:Q4, the eight-quarter-ahead forecast is made in 1998:Q4, and we also have the 1999:Q4 forecast made in 1998:Q4.

Modified forecast revisions with different revision spans

Following CG model:The problems with data availability (2) revision within one quarter, but …



Modified forecast revisions with different revision spans

proposed to reflect the forecast revision within one quarter

- One-quarter difference:
  - $\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-1}[\pi_{t+3}]\} + u_t$
  - $\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K_1\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t+4}]\} + K_2\{\bar{E}_{t-4}[\pi_{t+4}] - \bar{E}_{t-1}[\pi_{t+3}]\} + u_t$
- Two-quarter difference:
  - $\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-2}[\pi_{t+2}]\} + u_t$
  - $\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K_1\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t+4}]\} + K_2\{\bar{E}_{t-4}[\pi_{t+4}] - \bar{E}_{t-2}[\pi_{t+2}]\} + u_t$
- Three-quarter difference:
  - $\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-3}[\pi_{t+1}]\} + u_t$
  - $\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K_1\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t+4}]\} + K_2\{\bar{E}_{t-4}[\pi_{t+4}] - \bar{E}_{t-3}[\pi_{t+1}]\} + u_t$

Empirical Results

Analysis using CIP data

Variables in the empirical model

- Forecast error : $\pi_{t+4} - \bar{E}_t[\pi_{t+4}]$
- CG Forecast revision : $\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t+4}]$
- Modified forecast revision (Q4) : $\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_t]$
- Decomposed modified forecast revision
  - Forecast revision : $\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t+4}]$
  - Forecast trend : $\bar{E}_{t-4}[\pi_{t+4}] - \bar{E}_{t-4}[\pi_t]$

The CG regression & the modified regression

- Forecast error = α + K・Forecast revision
  1. CG forecast revision: $K_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t+4}]\}$
  2. Modified forecast revision: $K_{ZY}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_t]\}$

(1) Column 1: rejects the null hypothesis of the FIRE that the forecast error is independent of the CG forecast revision.

(2) Column 2: the coefficient of the modified forecast revision is similar to that of the CG forecast revision.

	Model 1	**Model 2**
CG forecast revision	0.606***	
	(0.181)	
Modified forecast revision		0.614***
		(0.182)
Constant	0.373***	0.260***
	(0.107)	(0.086)
R-squared	0.085	0.091
Num. obs.	126	126

***p < 0.01; **p <0.05;*p < 0.1

Controlling the consumption tax hikes

Japan’s Consumption Tax

- Historical facts
  - 3% (April 1989), raised to 5% (April 1997), raised to 8% (April 2014), raised to 10% (October 2019)
- Obviously, inflation increases after a rise in the consumption tax.

- Consumption tax hike dummies
  - Dummies take a value of one for the introducing quarter and the subsequent three quarters. Dummy for four quarters (= **one year)**
    - Dummy 3% to 5% (1997Q2-1998Q1)
    - Dummy 5% to 8% (2014Q2-2015Q1)
    - Dummy 8% to 10% (2019Q4-2020Q3)

- The inflation rate is calculated on a year-on-year basis. The effect of the consumption tax hike is still reflected even a quarter after its introduction, since prices are compared with those of the same month one year earlier.

The effect of consumption tax hike dummies

- With the underlying ‘information rigidity’ theoretical models of CG, there should not be any control variables affecting the forecast errors.
- ※Please keep in mind that the dependent variable is not a ‘forecast’, but it is the forecast error.

- The null hypothesis: (Rational Expectation)
- H0: the coefficients of dummies are not statistically significant
  - Dummy 3% to 5%=0
  - Dummy 5% to 8% =0
  - Dummy 8% to 10% = 0

Regression with consumption tax hike dummies

- Forecast error$_t$ = α + K・Forecast revision
  - $K_{CG}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t+4}]\}$
  - $K_{ZY}\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_t]\}$

(1) The coefficients of forecast revisions decreased with dummies, but the results are not altered qualitatively.

(2) The first two earlier consumption tax hike dummies are statistically significant at the one percent level.

(3) With three additional dummies, the fitness of the regression improved substantially.

(4) These results support that Japanese inflation follows non-rational expectations.

	Model 1	**Model 2**	**Model 3**	**Model 4**
CG forecast revision	0.606***	0.451***		
	(0.181)	(0.191)		
Modified forecast revision			0.614***	0.430**
			(0.182)	(0.186)
dummy 3% to 5%		1.756***		1.684***
		(0.157)		(0.167)
dummy 5% to 8%		1.849***		1.878***
		(0.376)		(0.365)
dummy 8% to 10%		-0.333*		-0.268*
		(0.168)		(0.159)
Constant	0.373***	0.241***	0.260***	0.156*
	(0.107)	(0.112)	(0.086)	(0.088)
Adj. R-squared	0.085	0.256	0.091	0.254
Num. obs.	126	126	126	126

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

Why is the consumption tax hike pre-announcement not orthogonal to forecast errors?

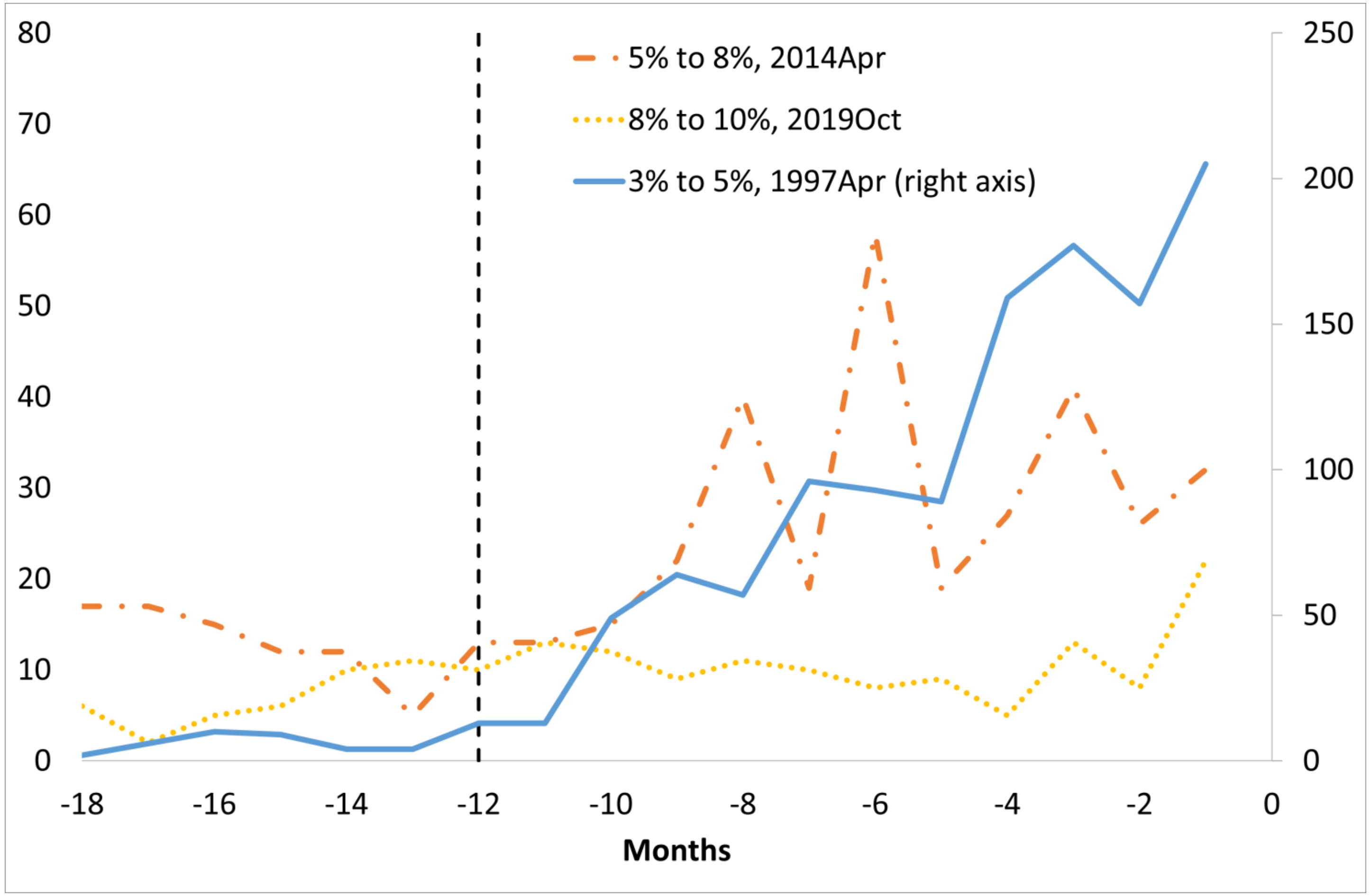
Consumption tax hike pre-announcement

- One crucial issue remains: whether the consumption tax hikes were correctly anticipated by Japanese consumers in the quarter one year earlier.

- Forecast errors on inflation observed in the month of the consumption tax increase should be orthogonal to the forecast revision made one year earlier if the tax increase is correctly anticipated.
- However, the forecast error can be positive in a substantial size if consumers are taken by surprise after making a forecast.

Consumption tax hike anticipations

- Following the works of Baker et al. (2016) and Yoshida (2025), we suggest using the media coverage to represent the degree of tax hike anticipation.
- The number of newspaper articles containing the relevant phrase of ’consumption tax increase’ appearing in the corresponding months is depicted.
- Forecast errors on inflation observed in the month of the consumption tax increase should be orthogonal to the forecast revision made one year earlier <u>if the tax increase is correctly anticipated</u>.



Note: We selected the Nikkei newspaper’s morning and evening issues to count the articles containing either of the keywords over an entire month.

The link between the CG and Modified forecast revision: Decomposing the modified forecast revision into two terms

Null Hypothesis with the decomposed regressions

- With decomposed regression,

$$\pi_{t+4} - \bar{E}_t[\pi_{t+4}] \\ = \alpha + K_1\underbrace{\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}\,[\pi_{t+4}]\}}_{\text{Precisely the same as the forecast revision}} + K_2\underbrace{\{\bar{E}_{t-4}\,[\pi_{t+4}] - \bar{E}_{t-4}[\pi_t]\}}_{\text{Forecast trend = (2year – 1year)}} + u_t$$

- K1
    - H0: K1= 0 (Full information Rational Expectation, FIRE)
    - H1: K1>0 (Information Rigidity Rational Expectation)
- K2
    - H0: K2 = 0 (rational expectation)
    - H1: K2 ≠ 0 (not rational expectation)

Decomposed regression

- $\pi_{t+4} - \bar{E}_t[\pi_{t+4}] = \alpha + K_1\{\bar{E}_t[\pi_{t+4}] - \bar{E}_{t-4}[\pi_{t+4}]\} + K_2\{\bar{E}_{t-4}[\pi_{t+4}] - \bar{E}_{t-4}[\pi_t]\} + u_t$

(1) Forecast trend is not statistically significant, whereas the forecast revision is statistically significant at the one percent level.

(2) These results support the original CG model over the modified forecast revision model, although the Wald test cannot reject the equality of K_1 and K_2

	Model 1	**Model 2**
Forecast revision	0.622***	0.454***
	(0.186)	(0.192)
Forecast trend Q4	0.500	0.111
	(0.513)	(0.496)
dummy 3% to 5%		1.738***
		(0.171)
dummy 5% to 8%		1.849***
		(0.377)
dummy 8% to 10%		-0.317*
		(0.189)
Constant	0.283**	0.221
	(0.146)	(0.154)
Adj. R-squared	0.084	0.250
Num. obs.	126	126
Wald	0.06	0.44

***p < 0.01; **p < 0.05; *p < 0.1

Alternative Modified forecast revision with 3 quarters, 2 quarters, and 1 quarter difference

The modified forecast revisions

JPN	1-year ahdad	2-year ahead	3-year ahead	4-year ahead
1999Q4		◎		
2000Q1				
2000Q2				
2000Q3				
2000Q4	◎			

consistent with the CG specification. 2001Q4

JPN	1-year ahdad	2-year ahead	3-year ahead	4-year ahead
1999Q4	○			
2000Q1	△			
2000Q2	▲			
2000Q3	□			
2000Q4	○△ ▲ □			

Alternative specifications for the modified forecast revisions.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Modified forecast revision Q3	0.708***					
	(0.223)					
Modified forecast revision Q2		1.107***				
		(0.327)				
Modified forecast revision Q1			2.173***			
			(0.542)			
CG Forecast revision				0.718***	1.128***	2.169***
				(0.230)	(0.336)	(0.558)
Forecast trend Q3				1.004**		
				(0.441)		
Forecast trend Q2					1.263***	
					(0.465)	
Forecast trend Q1						2.161***
						(0.641)
dummy 3% to 5%	1.650***	1.629***	1.640***	1.604***	1.609***	1.641***
	(0.159)	(0.193)	(0.188)	(0.157)	(0.199)	(0.185)
dummy 5% to 8%	1.763***	1.725***	1.807***	1.802***	1.763***	1.803***
	(0.337)	(0.268)	(0.236)	(0.335)	(0.274)	(0.277)
dummy 8% to 10%	-0.259	-0.256*	-0.256	-0.214	-0.235	-0.257
	(0.160)	(0.150)	(0.160)	(0.185)	(0.166)	(0.172)
Constant	0.159*	0.161*	0.156*	0.105	0.134	0.158
	(0.085)	(0.083)	(0.080)	(0.134)	(0.118)	(0.109)
Adj. R-squared	0.293	0.326	0.366	0.292	0.322	0.360
Num. obs.	126	126	126	126	126	126
Wald				0.59	0.25	0.00

***p < 0.01; **p < 0.05; *p < 0.1

Summary of the results

(1) Modified forecast revision and consumption tax hike dummies are all statistically significant.

(2) In the decomposition models, ‘Forecast trends’ are statistically significant for 3-quarters, 2-quarters, and 1-quarter differences.

(3) Regarding the equality of coefficients, K_1 and K_2, F-values for the Wald test cannot reject the null of $K_1 = K_2$.

These results show that modified forecast revision models introduced in this study fit better in the Japanese inflation expectation over the original CG model.

Zero inflation period sample

Structural break check

- Both inflation and inflation expectations in Japan have been peculiar over the last three decades; they only became positive recently in the post-COVID period.
- It is worth examining whether inflation expectations in Japan have experienced a structural break in the recent post-COVID period. Therefore, we re-estimated the models with the subsample of only up to 2019 Q4.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
CG Forecast revision	0.219	-0.162			0.165	-0.243
	(0.225)	(0.179)			(0.241)	(0.179)
Modified forecast revision			0.294	-0.039		
			(0.191)	(0.154)		
Forecast trend					1.393**	1.445***
					(0.597)	(0.521)
dummy 3% to 5%		1.919***		1.915***		1.729***
		(0.165)		(0.167)		(0.173)
dummy 5% to 8%		2.496***		2.386***		2.655***
		(0.341)		(0.331)		(0.334)
dummy 8% to 10%		-0.239**		-0.277		-0.02
		(0.100)		(0.083)		(0.146)
Constant	0.206**	-0.062	0.16*	-0.016	-0.117	-0.404**
	(0.131)	(0.106)	(0.093)	(0.081)	(0.222)	(0.187)
R-squared	0.003	0.371	0.016	0.366	0.034	0.407
Num. obs.	105	105	105	105	105	105
Wald					2.83*	7.50***

***p < 0.01; **p < 0.05; *p < 0.1

(1) Both the original and modified forecast revisions are not statistically significant. Under the zero-inflation regime in Japan, people formed their forecasts in accordance with rational expectations.
(2) The forecast trends and the consumption tax hike dummies are statistically significant. This evidence warrants us to reconsider the information rigidity model of Coibion and Gorodnichenko (2015).
(3) The null of $K_1 = K_2$ is rejected in columns 5 and 6.

Time-varying parameter estimates

Time-varying parameter estimates

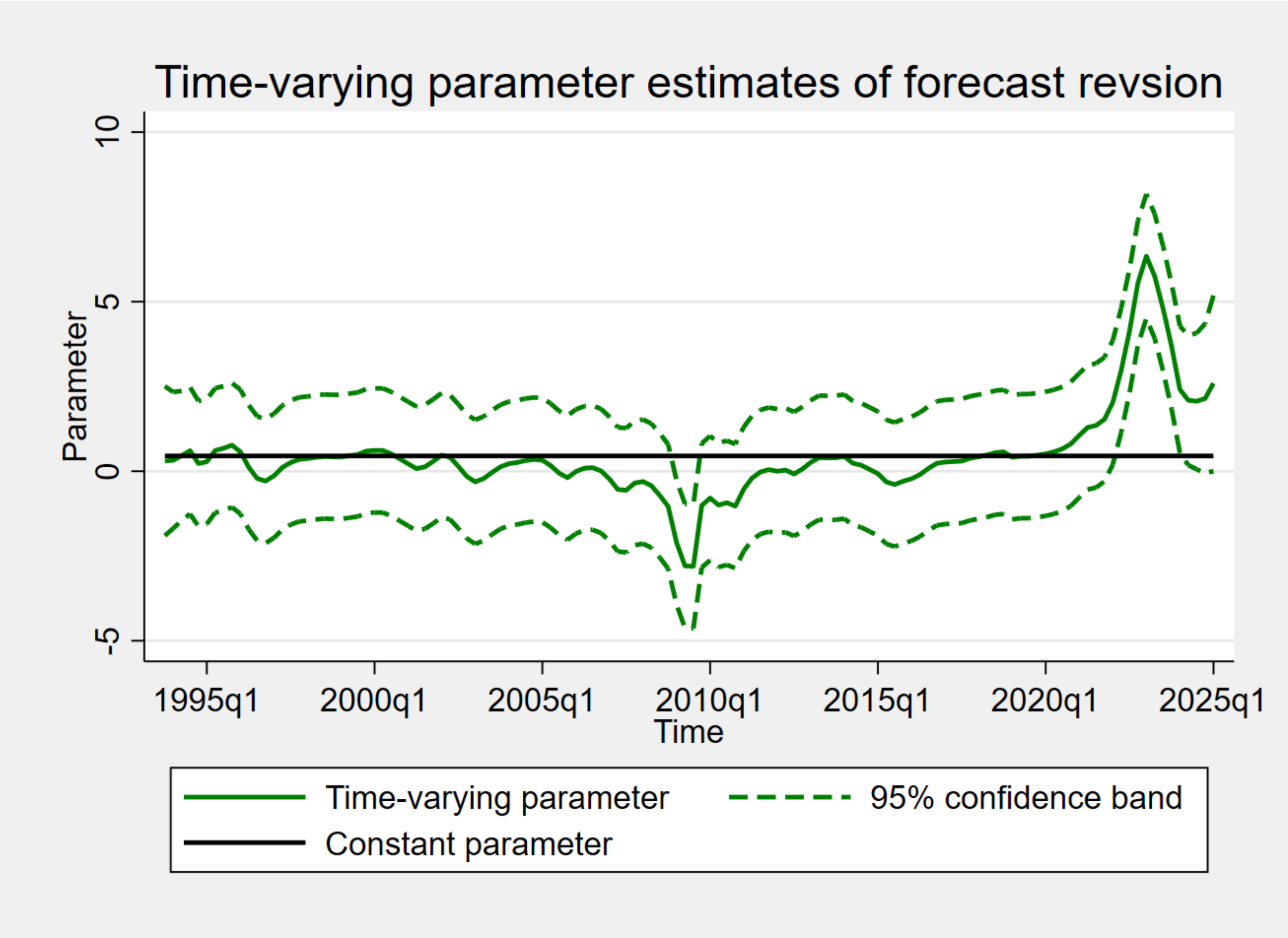
- So far, we have split the sample into the zero-inflation or zero-interest rate period and the post-COVID period, the latter of which is associated with a non-zero inflation period.
- Though this particular structural break point may be agreeable to the majority of economists, there is no statistical ground to support this break.

- We follow the methodology proposed in Inoue et al. (2024), Inoue et al. (2025), and Muller and Petalas (2010) to capture the smooth dynamics of parameter changes of forecast revision effect on the forecast errors

Dynamics of parameter changes of forecast revision

- Forecast revision has no effect on forecast errors in the 90s, 00s, and 10s, except in the wake of the global financial shock.

- The peak occurs in the first quarter of 2023, the point estimate reaching 6.34. The positive effect of forecast revision is statistically significant between 2022:Q1 and 2025:Q1, except for the last quarter in 2024.



Overall Summary

- Driven by the data unavailability in forecast horizons in the Japanese dataset, we introduced the modified form of 'forecast revision', which is closely related with the original 'forecast revision' of Coibion and Gorodnichenko (2015). We find this new 'forecast revision' term is useful in investigating inflation forecasts.

- The finding of both $K_{CG} > 0$ and $K'_{CG} > 0$ rejects full-information rational expectations (FIRE) in Japan. More precisely, they are consistent with the rational expectations model with information rigidity.
    - When forecasters revise upward their estimation of inflation, they always underreact to the new information.

- In the decomposition model, we find the coefficient of forecast trend, $K_2>0$, indicating that the forecast is too low when increasing the forecast trend. And this contradicts rational expectations. People in Japan forecast inflation under information rigidity and form their expectations that deviate from the rational expectations.

- Finally, under the zero-inflation regime in Japan, people formed their forecasts in accordance with rational expectations, and there was no information frictions. = FIRE!