Lumpy Forecasts

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- Does this assumption hold for **inflation surveys**? If not, what drives the difference?
- Crucial implications for **survey design** and for conducting **monetary policy**

What do we do

- **New facts: Survey of professionals that forecast end-of-year inflation**

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  2. Horizon-dependent revisions
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- **New model: Bayesian + Preference for Stability + Strategic Concerns**
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- **Implications of lumpy forecasts**:
  - **Micro:** Forecast rationality (efficiency) tests
  - **Macro:** State-dependent responses to volatility

Roadmap

1. **Data and fixed-event forecasting**
2. Term structure of forecast revisions and errors
3. A model of lumpy forecasts
4. Implications

Data description

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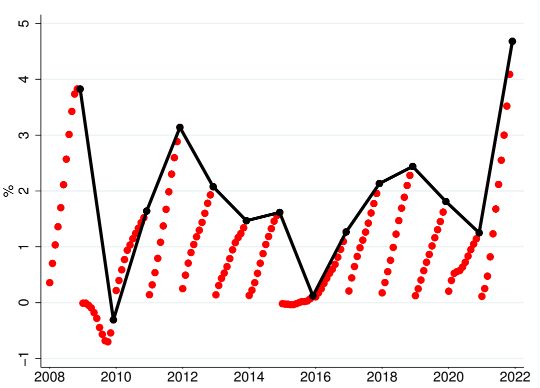
- Four types of forecasters:
  - banks, financial institutions, consulting companies, universities & research centers
- Incentives:
  - Public exposure, citations in newsletters
  - Forecasts drive trading behavior [Bahaj et.al. (23)]

Annual CPI inflation π_t

$$\pi_t = \underbrace{\log(\overline{cpi}_t) - \log(\overline{cpi}_{t-1})}_{\text{annual inflation}} \approx \sum_{m=1}^{12} \underbrace{\frac{1}{12}\left[\log(cpi_{m,t}) - \log(cpi_{m-12,t})\right]}_{x_m \,\equiv\, \text{year-on-year monthly inflation}} = \sum_{m=1}^{12} x_m$$



Fixed-event forecasting [Nordhaus, 1987; Patton and Timmermann, 2011, 2012]

- In a given year, fixed event $\pi = \sum_{h=1}^{12} x_h$
  - horizon $h \in \{12, 11, 10, ..., 2, 1\}$ runs backward
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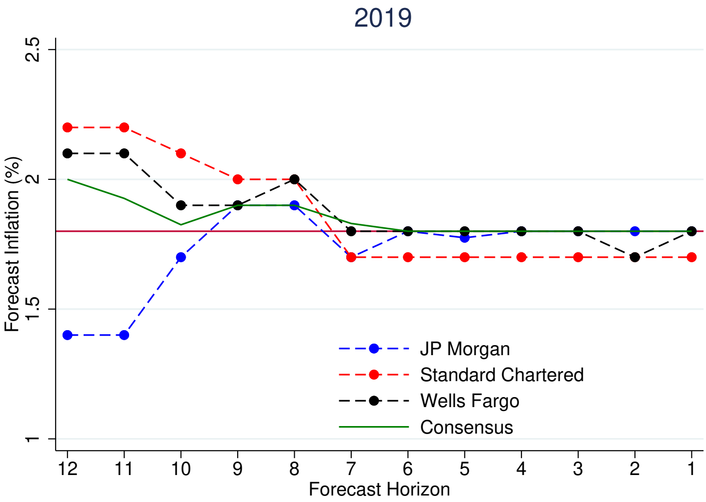
  - horizon $h \in \{12, 11, 10, ..., 2, 1\}$ runs backward
  - x_h's are publicly observed every month
- Forecast f_h^i about π by agent i at horizon h

$$f_h^i = \underbrace{\mathcal{P}_h^i}_{\text{projection}} + \underbrace{\sum_{j=h+1}^{12} x_j}_{\text{past realizations}} \qquad h = 12, \ldots, 1$$

Example of three forecasters in a year



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1. Data and fixed event forecasting
2. **Term structure of forecast revisions and errors**
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Forecast revisions and errors

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  - Forecast revisions: $\Delta f_h^i \equiv f_h^i - f_{h+1}^i$
  - Forecast errors: $e_h^i \equiv \pi - f_h^i$

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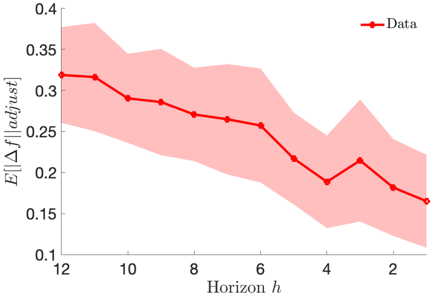
- Random walk "naive" benchmark
  - Projection: $\mathcal{P}_h = h \cdot x_{h+1}$
  - $\Delta f_h = (h+1) \cdot \Delta x_{h+1}$ and $e_h = \sum_{j=1}^{h} x_j - h \cdot x_{h+1}$

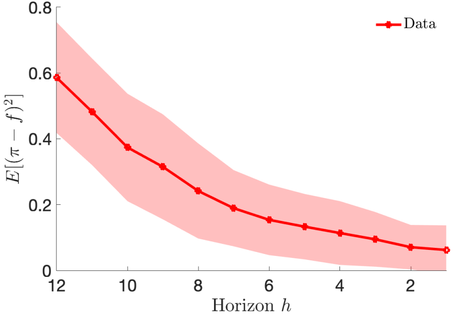
Term structure of revisions and errors

- Size of revision: $\mathbb{E}\left[|\Delta f_h^i|\,|\text{adjust}\right] = 0.25$ Stylized facts - Revisions
- Mean squared error: $\mathbb{E}[(e_h^i)^2] = 0.24$ Stylized facts - Errors

(a) Size of non-zero revisions



(b) Mean Squared Error



Larger revisions and errors relative to a random walk

- Size of revision: $\mathbb{E}\left[\left|\Delta f_h^i\right| \middle| \text{adjust}\right] = 0.25$ vs. 0.16 random walk
- Mean squared error: $\mathbb{E}[(e_h^i)^2] = 0.24$ vs. 0.15 random walk

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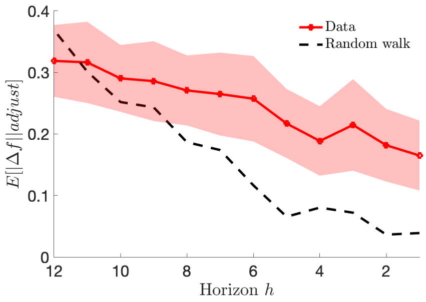

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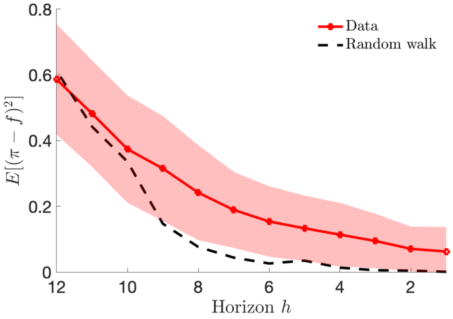

Forecast revisions are *lumpy*

- Frequency: $\Pr[\Delta f_h^i \neq 0] = 0.43$ (5 revisions/year, avg. duration 1.6 months)
- Decreasing hazard: $h(age) = \Pr[\Delta f \neq 0 | age]$

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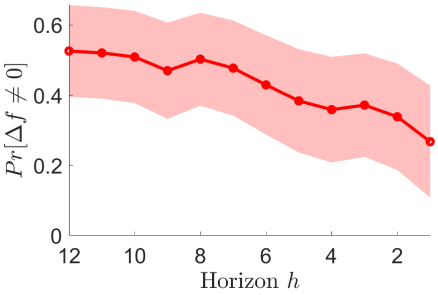
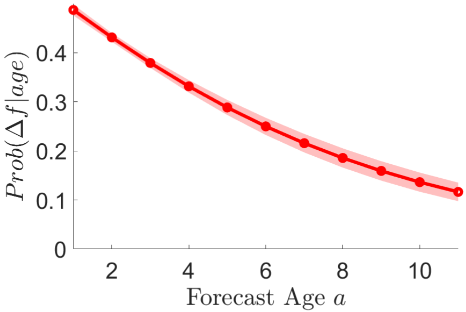


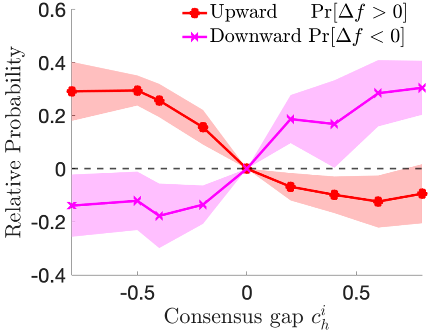
(b) Hazard Rate



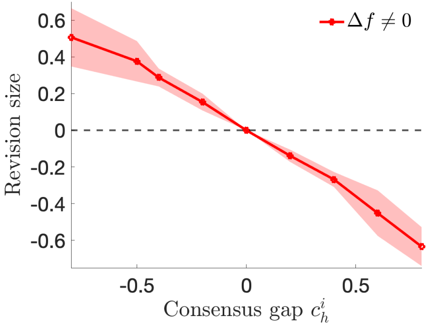
Gap to consensus triggers revisions

- Consensus: $F_h = \frac{1}{N}\sum_{h=1}^{12} f_h^i$
- Gap to consensus: $c_h^i \equiv f_{h+1}^i - F_h$

(a) Gaps increase frequency



(b) Revisions close the gap



Robustness

A1. Rounding – Consensus Economics

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A2. Longer horizons (18 months)

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A3. Other surveys

  A3a. Professionals in ECB survey [Andrade and Le Bihan (2013)]

  A3b. Firms' expectations also lumpy [Born, et.al., Handbook of Economic Expectations]

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Setup

- N forecasters i choose inflation forecast f_h^i to minimize sum of monthly losses

$$\min_{\{f_h^i\}_{h=12}^{1}} \mathbb{E}\left[\sum_{h=12}^{1} \underbrace{(f_h^i - \pi)^2}_{\text{accuracy}} + r \underbrace{(f_h^i - F_h)^2}_{\text{strategic}} + \underbrace{\kappa \mathbb{1}_{\{f_h^i \neq f_{h+1}^i\}}}_{\text{stability}} \right]$$

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- **End-of-year inflation:** $\pi = \sum_{h=1}^{12} x_h$

- **Consensus:** $F_h = N^{-1} \sum_{i=1}^{N} f_h^i$

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- **End-of-year inflation:** $\pi = \sum_{h=1}^{12} x_h$
    - AR(1) structure: $x_h = c_x + \phi_x x_{h+1} + \varepsilon_h^x$, $\varepsilon_h^x \sim \mathcal{N}(0, \sigma_x^2)$ (one period delay)
    - Private signal: $\tilde{x}_h^i = x_h + \zeta_h^i$, idiosyncratic noise $\zeta_h^i \overset{\text{iid}}{\sim} \mathcal{N}(0, \sigma_\zeta^2)$
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- **Information set:** $\mathcal{I}_h^i = \tilde{x}_h^i \cup \mathcal{I}_h = \tilde{x}_h^i \cup \{x_{h+1}, x_{h+2}, \ldots, F_{h+1}, F_{h+2}, \ldots\}$

Belief formation

- Using the law of iterated expectations:

$$\min_{\{f_h^i\}_{h=12}^{1}} \sum_{h=12}^{1} \underbrace{\Sigma_h}_{\text{sunk}} + \underbrace{(f_h^i - \mathbb{E}[\pi|\mathcal{I}_h^i])^2}_{\text{accuracy}} + r \underbrace{(f_h^i - \mathbb{E}[F_h|\mathcal{I}_h^i])^2}_{\text{strategic}} + \underbrace{\kappa\mathbb{E}[\mathbb{1}_{\{f_h^i \neq f_{h+1}^i\}}|\mathcal{I}_h^i]}_{\text{stability}}$$

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  - $$\hat{\pi}_h^i = \underbrace{h\left(\frac{c_x}{1-\phi_x}\right) + \frac{1-\phi_x^h}{1-\phi_x}\left(\hat{x}_h^i - \frac{c_x}{1-\phi_x}\right)}_{\text{AR(1) projection}} + \underbrace{\sum_{j=h+1}^{12} x_j}_{\text{realized, } j>h}, \quad h = 12, \dots, 1$$

where $\hat{x}_h^i \equiv \mathbb{E}[x_h|\mathcal{I}_h^i] = \alpha[c_x + \phi_x x_{h+1}] + (1-\alpha)\tilde{x}_h^i$, w/weight $\alpha \equiv \frac{(\sigma_x^2)^{-1}}{(\sigma_x^2)^{-1} + (\sigma_\zeta^2)^{-1}}$

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  - $\hat{F}_h = \hat{F}_{h+1} + \eta_h^{\hat{F}}$ (agents' perceive a unit root process)

Restricted perceptions equilibrium

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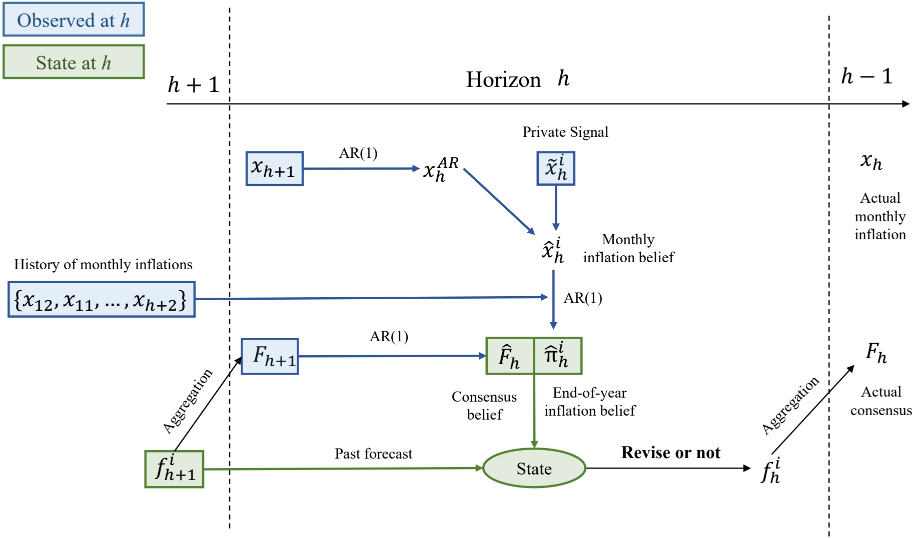
- **Total uncertainty:** $\Sigma_h \equiv \Sigma_h^\pi + r\sigma_F^2$
  - Σ_h^π falls deterministically with h and independent of i

Timeline


Observed at h
State at h
$h+1$
Horizon h
$h-1$
Private Signal
x_{h+1}
AR(1)
x_h^{AR}
$\tilde{x}_h^i$
x_h
Actual monthly inflation
$\hat{x}_h^i$
Monthly inflation belief
History of monthly inflations
$\{x_{12}, x_{11}, \dots, x_{h+2}\}$
AR(1)
AR(1)
F_{h+1}
$\hat{F}_h$
$\hat{\pi}_h^i$
F_h
Aggregation
Consensus belief
End-of-year inflation belief
Aggregation
Actual consensus
f_{h+1}^i
Past forecast
State
Revise or not
f_h^i

Recursive problem and optimal policy

$$\mathcal{V}_h(\hat{\pi}, \hat{F}, f) \;=\; \min\{ \underbrace{\mathcal{V}_h^I(\hat{\pi}, \hat{F}, f)}_{\text{inaction}}, \;\; \underbrace{\mathcal{V}_h^A(\hat{\pi}, \hat{F})}_{\text{action}} \}$$

$$\begin{aligned}
\mathcal{V}_h^I(\hat{\pi}, \hat{F}, f) &= \Sigma_h + (f - \hat{\pi})^2 + r(f - \hat{F})^2 + \mathbb{E}[\mathcal{V}_{h-1}(\hat{\pi}', \hat{F}', f)|\mathcal{I}] \\
\mathcal{V}_h^A(\hat{\pi}, \hat{F}) &= \kappa + \Sigma_h + \min_{f^*} \Big\{ (f^* - \hat{\pi})^2 + r(f^* - \hat{F})^2 + \mathbb{E}[\mathcal{V}_{h-1}(\hat{\pi}', \hat{F}', f^*)|\mathcal{I}] \Big\}
\end{aligned}$$

Recursive problem and optimal policy

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- Optimal policy is horizon-dependent:
  - Inaction region: $\mathcal{R}_h \equiv \{(\hat{\pi}, \hat{F}, f) : \mathcal{V}^I_h(\hat{\pi}, \hat{F}, f) \geq \mathcal{V}^A_h(\hat{\pi}, \hat{F})\}$
  - New forecast: ${f_h}^*(\hat{\pi}, \hat{F})$
  - Revisions: $\Delta f_h = \begin{cases} 0, & \text{if } f \in \mathcal{R}_h \\ {f_h}^* - f & \text{if } f \notin \mathcal{R}_h \end{cases}$

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- **Calibration**

Parameter		Value	Moment	Data	Model
κ	adjustment cost	0.06	$\Pr[\Delta f \neq 0]$	0.43	0.41
r	strategic concerns	0.79	$\mathbb{E}[\lvert\Delta f\rvert \lvert \text{adjust}]$	0.25	0.19
σ_ζ	private noise	0.05	hazard slope	-0.04	-0.04

  - Consensus volatility $\sigma_F^2 = 0.11$ yields belief consistency Consistency

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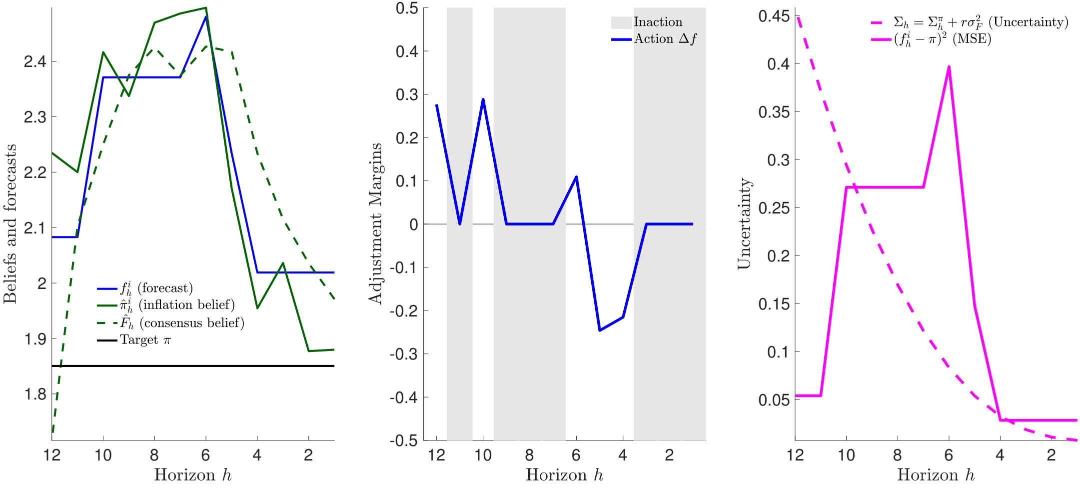
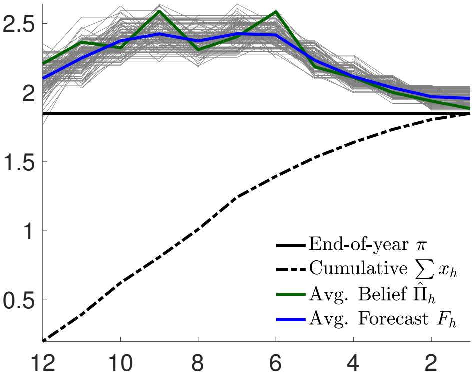
- **Microdata implies:**
  - ⋆ Stability: $\kappa > 0$
  - ⋆ Complementarity: $r > 0$
  - ⋆ Private information: $\alpha = 0.45$

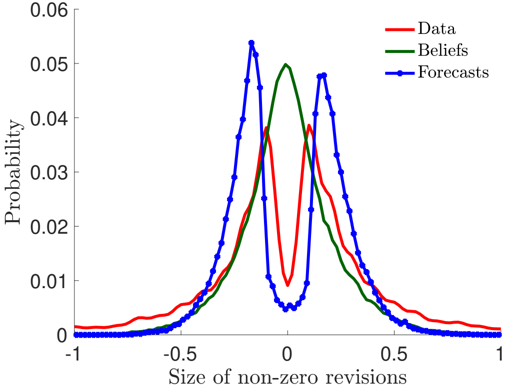
Model in action

Forecasts vs. Beliefs (one forecaster)



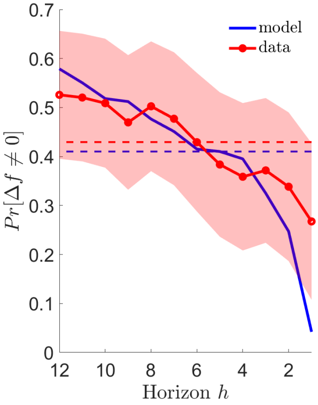
Forecasts vs. Beliefs (in the aggregate)



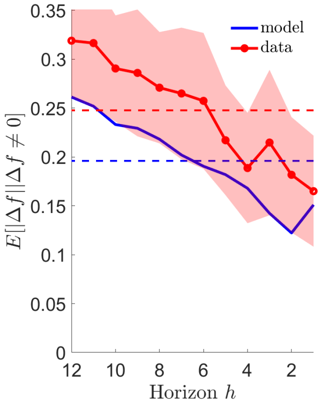


Untargeted term structures

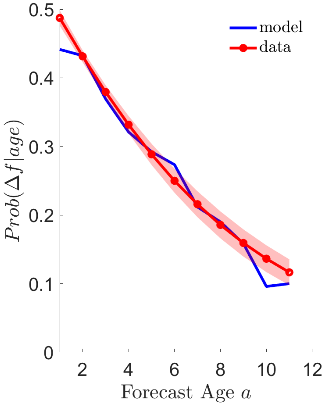
(a) Frequency of revisions



(b) Size of non-zero revisions

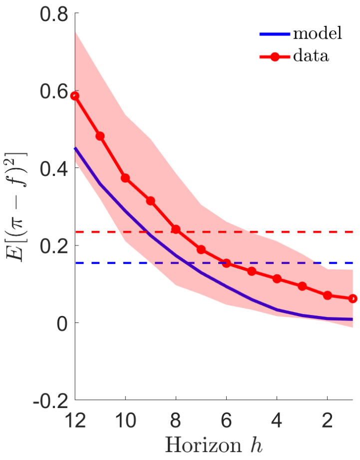


(c) Hazard rate



Other untargeted moments

Mean squared error



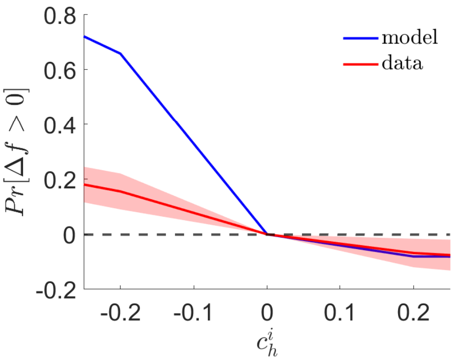
Autocorrelations

	Data	Model
Forecast errors	0.88	0.70
Belief errors	N/A	0.60
All revisions	−0.04	−0.06
Non-zero revisions	−0.11	−0.15

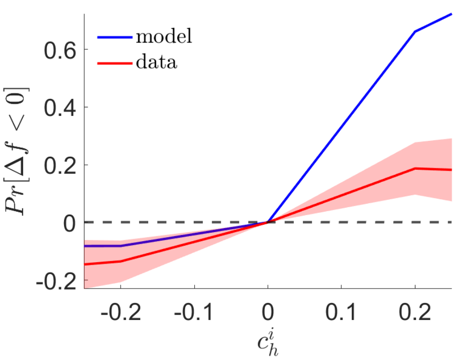
Gap to consensus triggers adjustments

- Gap to consensus: $c_h^i \equiv f_{h+1}^i - F_h$

(a) Prob. of Upward Adjustment



(b) Prob. of Downward Adjustment



Heterogeneity

Heterogeneity across forecaster types

- Cross-sectional moments by forecaster type

	Financial Inst.		Banks		Consulting		Universities	
Moment	Data	Model	Data	Model	Data	Model	Data	Model
$\Pr[\Delta f \neq 0]$	0.45	0.40	0.38	0.37	0.47	0.49	0.34	0.35
$\mathbb{E}[\lvert\Delta f\rvert \,\big\vert\, adjust]$	0.25	0.18	0.26	0.24	0.27	0.18	0.29	0.30
hazard slope	−0.05	−0.05	−0.02	−0.02	−0.05	−0.05	−0.01	−0.01
N		5,366		2,567		2,982		1,440

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N		5,366		2,567		2,982		1,440

- Relative parameters by forecaster type, within group consensus

Parameter	**Financial Inst.**	**Banks**	**Consulting**	**Universities**
κ	1.00	1.17	0.83	1.33
r	1.00	0.64	0.94	0.20
σ_ζ	1.00	0.75	0.75	1.25

Note: Parameters relative to financial institutions

⋆ University forecasts are the lumpiest, least strategic and noisiest

Roadmap

1. Data and fixed event forecasting
2. Term structure of forecast revisions and errors
3. A model of lumpy forecasts
4. **Implications**

Forecast rationality tests

Forecasts rationality tests

- Predictability of individual forecast errors (assumption: forecasts = beliefs)

$$\underbrace{\pi - f_h^i}_{\text{forecast error}} = \underbrace{\gamma_0^h}_{\text{bias}} + \gamma_1^h \underbrace{(f_h^i - f_{h+1}^i)}_{\text{revision}} + \gamma_2^h \underbrace{(F_{h+1} - f_{h+1}^i)}_{\text{consensus}} + \epsilon_h^i$$

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- Rational expectations: $\gamma_0^h = \gamma_1^h = \gamma_2^h = 0$

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- Literature finds deviations:
  - Overreaction to private info: $\gamma_1^h < 0$
    Bordalo *et.al.* (2020) for $h = 9$, Afrouzi *et.al.* (2023)
  - Underreaction to public info: $\gamma_2^h > 0$
    Broer and Kohlhas (2022) and Gemmi and Valchev (2022) for $h = 6, 9$

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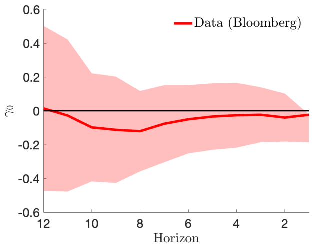
  - Underreaction to public info: $\gamma_2^h > 0$
    Broer and Kohlhas (2022) and Gemmi and Valchev (2022) for $h = 6, 9$
- We distinguish forecasts from beliefs, and run test for each horizon

Rationality tests (data)

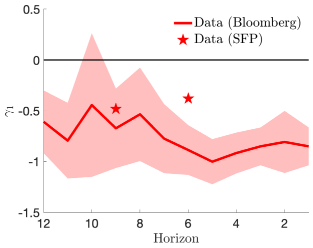
$$\pi - f_h^i = \gamma_0^h + \gamma_1^h \left(f_h^i - f_{h+1}^i\right) + \gamma_2^h \left(F_{h+1} - f_{h+1}^i\right) + \epsilon_h^i$$

- Forecasts over-react to private info $(\gamma_1^h < 0)$
- Forecasts under-react to public info $(\gamma_2^h > 0)$

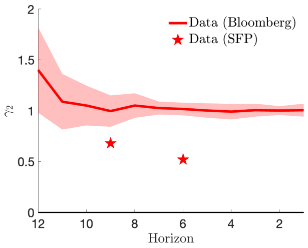
(a) Bias



(b) Revision



(c) Consensus

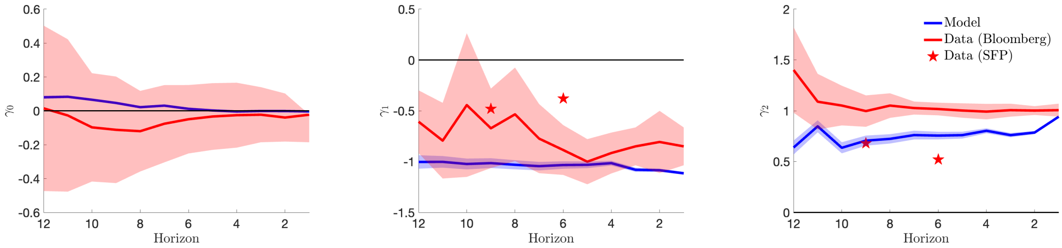


Rationality tests (data and model)

$$\pi - f_h^i = \gamma_0^h + \gamma_1^h \left(f_h^i - f_{h+1}^i\right) + \gamma_2^h \left(F_{h+1} - f_{h+1}^i\right) + \epsilon_h^i$$

- Forecasts over-react to private info $(\gamma_1^h < 0)$
- Forecasts under-react to public info $(\gamma_2^h > 0)$

(a) Bias (b) Revision (c) Consensus

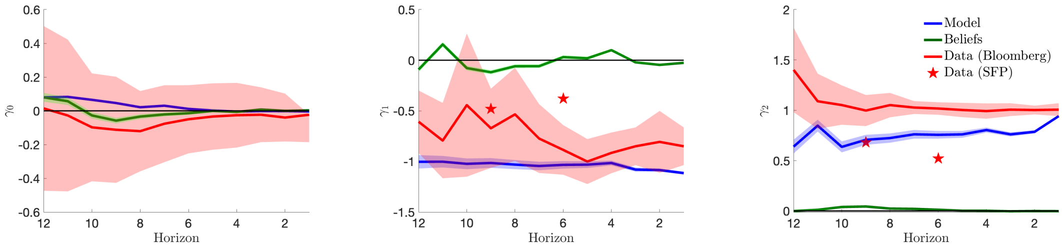


Rationality tests (using beliefs)

$$\pi - \hat{\pi}^i_h \ = \ \gamma^h_0 \ + \ \gamma^h_1 \left(\hat{\pi}^i_h - \hat{\pi}^i_{h+1}\right) \ + \ \gamma^h_2 \left(\hat{\Pi}_{h+1} - \hat{\pi}^i_{h+1}\right) \ + \ \epsilon^i_h$$

- Beliefs consistent with rational expectations $(\gamma^h_0 = \gamma^h_1 = \gamma^h_2 = 0)$

(a) Bias (b) Revision (c) Consensus



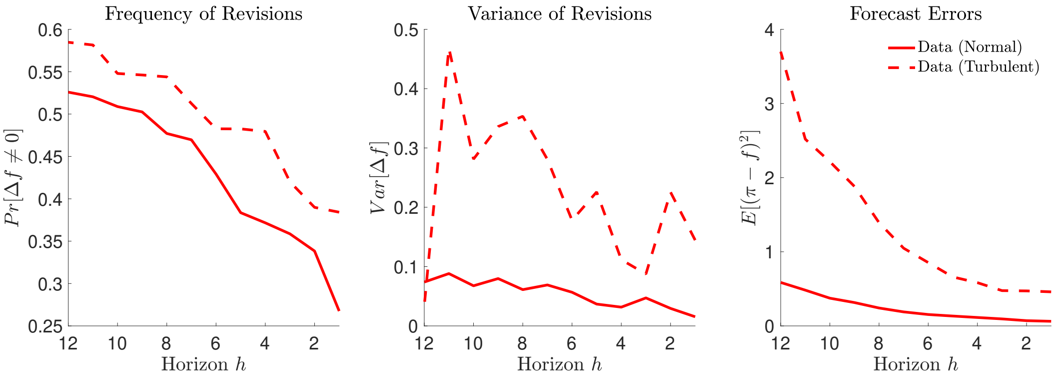
Rationality tests with multi-horizons, [Patton and Timmermann, 2012]

Test	(I) Data	(II) Forecasts	(III) Beliefs
Inequality-based			
1. Increasing MSE	0.879	0.966	0.985
2. Increasing MSR^r	0.851	0.931	0.972
3. Decreasing MSF^r	**0.038**	0.94	0.944
4. Decreasing covariance	**0.071**	0.937	0.966
5. Decreasing covariance with proxy^r	**0.067**	0.907	0.959
6. Variance bound	0.16	0.774	0.771
7. Variance bound with proxy^r	**0.092**	0.711	0.825
MZ Regresion-based			
8. Univar opt revision	NaN	1.000	1.000
9. Univar opt revision with proxy	1.000	1.000	1.000
10. Univar MZ short h	**0.000**	**0.000**	0.194
Joint tests			
Bonferroni I (1+4 +6 +8 +10)	**0.000**	**0.000**	0.968
Bonferroni II (2+ 3+ 5+ 7+9)	0.192	1.000	1.000
Bonferroni All (1-10)	**0.000**	**0.000**	1.000

Responses to volatility

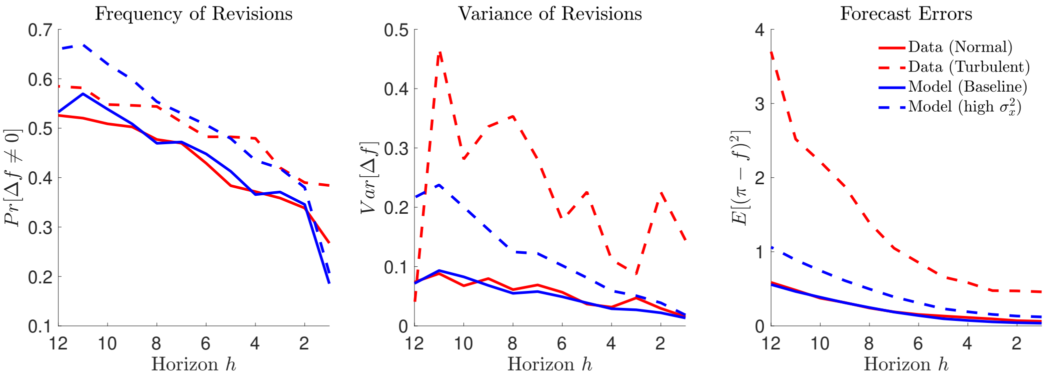
Changes in inflation volatility (in data)

- Turbulent years 2008-09 and 2020-21: $\sigma_x^2 \uparrow$ Time-series
- Frequency, variance, and errors increase at all horizons



Changes in inflation volatility

- Model – Increase in inflation volatility: $1.4 \times \sigma_x^2$
- Captures qualitative changes in cross-sectional moments



Conclusions

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- **Forecasts are lumpy**
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  - Forecast rationality tests
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Conclusion

- **Forecasts are lumpy**
  - Lumpiness amplified by strategic concerns
- **Bayesian learning + fixed revision cost + strategic concerns**
  - Explain the microdata
- **Lumpy forecasts help us understand...**
  - Forecast rationality tests
  - Responses to changes in volatility
- **Policy implications:**
  - Survey design: incentives/prizes (e.g., Brazilian FOCUS) [Issler, et.al 2022]
  - Transmission of monetary policy (companion project)

Thank you!

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Lumpy Forecasts

Isaac Baley
UPF, CREI, BSE, CEPR

Javier Turén
PUC Chile

NBER SI — July 12, 2024

Backup material

Appendix Index

Contributions

- **Forecast lumpiness**

  Mankiw & Reis (02), Reis (06), Andrade & Le Bihan (13), Gaglianone, Giacomini, Issler & Skreta (22)

  ⋆ We provide direct evidence with high frequency data

Contributions

- **Forecast lumpiness**
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  ⋆ We provide direct evidence with high frequency data
- **Inaction with learning**
  Álvarez, Lippi & Paciello (11), Baley & Blanco (19), Baley, Figueiredo & Ulbricht (22), Bonomo, et. al. (23)
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- **Rationality tests**
  Nordhaus (87), Vives (93), Patton & Timmermann (10, 12), Capistrán and López-Moctezuma (13), Coibion & Gorodnichenko (12, 15), Giacomini, Skreta & Turen (20), Bordalo, Gennaioli, Ma & Schleifer (20)
  ⋆ We show that lumpiness accounts for behavioral biases

A. Sample selection

Index

- Weekly observations, aggregated at the monthly level
- Keep forecaster with a minimum of 1 revision per year (at a monthly frequency)
- Eliminate extreme revisions

From yearly inflation to sum of year-on-year monthly inflation

- Let $\overline{cpi}_t = \frac{1}{12}\sum_{h=1}^{12} cpi_{t,h}$ be the average cpi in year t.
- The annual inflation equals:

$$
\begin{aligned}
\pi_t &= \log(\overline{cpi}_t) - \log(\overline{cpi}_{t-1}) \\
&= \log\left(\frac{1}{12}\sum_{h=1}^{12} cpi_{t,h}\right) - \log\left(\frac{1}{12}\sum_{h=1}^{12} cpi_{t-1,h}\right) \\
&\approx^{Jensen} \frac{1}{12}\sum_{h=1}^{12}\left(\log\left(cpi_{t,h}\right) - \log\left(cpi_{t-1,h}\right)\right) \\
&= \frac{1}{12}\sum_{h=1}^{12}\left(\log\left(cpi_{h}\right) - \log\left(cpi_{h+12}\right)\right) \\
&= \sum_{h=1}^{12} \underbrace{\frac{1}{12}\left(\log\left(cpi_{h}\right) - \log\left(cpi_{h+12}\right)\right)}_{x_h} = \sum_{h=1}^{12} x_h
\end{aligned}
$$

When is year-on-year monthly inflation a good approximation?

- A second-order Taylor approximation of $\log(p)$ around $\mathbb{E}[p]$ yields:

$$\log(p) \quad \approx \quad \log(\mathbb{E}[p]) + \frac{1}{\bar{p}}(p - \mathbb{E}[p]) - \frac{1}{2\mathbb{E}[p]^2}(p - \mathbb{E}[p])^2$$

- Take expectations on both sides (note that $\mathbb{E}[p]$ is a constant):

$$\mathbb{E}[\log(p)] \quad \approx \quad \log(\mathbb{E}[p]) - \frac{\mathbb{V}ar[p]}{2\mathbb{E}[p]^2} = \log(\mathbb{E}[p]) - \frac{\mathbb{CV}^2[p]}{2}$$

- Applying the decomposition to annual inflation (letting p, p' be the CPI in consecutive years)

$$\pi = \log(\mathbb{E}[p]) - \log(\mathbb{E}[p']) = \underbrace{\mathbb{E}[\log(p) - \log(p')]}_{\text{average year-on-year inflation } \mathbb{E}[x]} + \underbrace{\frac{\mathbb{CV}^2[p] - \mathbb{CV}^2[p']}{2}}_{\text{differences in within-year dispersion}}$$

- For similar within-year price dispersion ($\mathbb{CV}^2[p] \approx \mathbb{CV}^2[p']$), then $\pi \approx \mathbb{E}[x]$.

B1. Statistics of Forecast Revisions

Back Index

Forecast revisions $\Delta f_h^i = f_h^i - f_{h+1}^i$

Average	$\mathbb{E}[\Delta f]$	-0.013
Size	$\mathbb{E}[abs(\Delta f) \mid \Delta f \neq 0]$	0.247
Variance	$\mathbb{V}ar[\Delta f]$	0.055
Number of revisions in a year	$count[\Delta f \neq 0]$	5.059
Months of inaction	$\mathbb{E}[\tau]$	1.594
Adjustment frequency	$\Pr[\Delta f \neq 0]$	0.427
Upward	$\Pr[\Delta f > 0]$	0.196
Downward	$\Pr[\Delta f < 0]$	0.231
Spike rate	$\Pr[abs(\Delta f) > 0.2]$	0.028
Serial correlation (all Δf)	$corr[\Delta f, \Delta f_{-1}]$	-0.043
Serial correlation (non-zero Δf)	$corr[\Delta f, \Delta f_{-1}]$	-0.107
Observations	N	9,256

Notes: Bloomberg data for normal years 2010-2019.
Cross-sectional statistics are averaged across years and horizons.

B2. Statistics of Forecast Revisions: Normal vs. Turbulent

Back Index

		All	Turbulent	Normal
Average	$\mathbb{E}(\Delta f)$	−0.002	0.028	−0.013
Size	$\mathbb{E}(abs(\Delta f)\|\Delta f \neq 0)$	0.307	0.453	0.247
Variance	$\mathbb{V}ar(\Delta f)$	0.104	0.227	0.054
Frequency	$\Pr(\Delta f \neq 0)$	0.444	0.492	0.427
Upward	$\Pr(\Delta f) > 0$	0.228	0.318	0.196
Downward	$\Pr(\Delta f) < 0$	0.216	0.173	0.231
Inaction rate	$\Pr(\Delta f = 0)$	0.556	0.508	0.573
Number of revisions	$count(\Delta f \neq 0)$	5.204	5.602	5.059
Duration (months)	$\mathbb{E}(\tau)$	1.497	1.231	1.594
Spike rate	$abs(\Delta f/f) > 1.2$	0.081	0.231	0.028
Positive spikes	$\Delta f/f > 1.2$	0.076	0.227	0.023
Negative spikes	$\Delta f/f < -1.2$	0.005	0.004	0.005
Serial correlation (all)	$corr(\Delta f, \Delta f_{-1})$	−0.035	−0.035	−0.043
Serial correlation (non-zero)	$corr(\Delta f, \Delta f_{-1})$	−0.085	−0.078	−0.107
Annual Inflation	π	1.896	2.175	1.795
Observations	N	12,619	3,363	9,256

B3. Statistics of Forecast Errors

Back Index

Forecast errors $e_h^i = \pi - f_h^i$		
Average	$\mathbb{E}[e]$	−0.055
Average of squares	$\mathbb{E}[e^2]$	0.235
Size	$\mathbb{E}[abs(e)]$	0.305
Positive	$Pr[e > 0]$	0.345
Negative	$Pr[e < 0]$	0.572
Variance	$\mathbb{V}ar[e]$	0.252
Serial correlation	$corr[e, e_{-1}]$	0.877
Observations	N	9,256

Notes: Bloomberg data for normal years 2010-2019. Cross-sectional statistics are averaged across years and horizons.

B4. Statistics of Forecast Errors: Normal vs. Turbulent

Back Index

Table: Summary Statistics of Forecast Errors

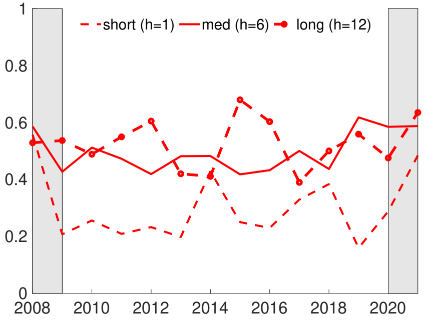
		All	**Turbulent**	**Normal**
Average	$\mathbb{E}(e)$	0.023	0.237	-0.055
Size	$\mathbb{E}(abs(e))$	0.434	0.789	0.305
Positive	$Pr(e > 0)$	0.414	0.606	0.345
Negative	$Pr(e < 0)$	0.510	0.340	0.572
Dispersion	$\sigma(e)$	0.663	1.105	0.502
Serial correlation	$corr(e, e_{-1})$	0.882	0.878	0.877
Observations	N	12,619	3,363	9,256

Time Series: Normal vs. Turbulent

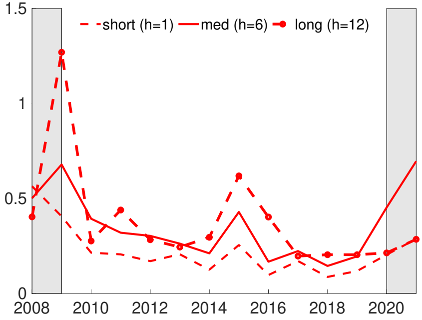
Back

- Normal years: 2010-19
- Turbulent years: 2008-09 and 2020-21

(a) Frequency by year × horizon



(b) Size by year × horizon



C1. Weekly data

Back Index

- We repeat the analysis using the weekly data directly.

C2. Rounding

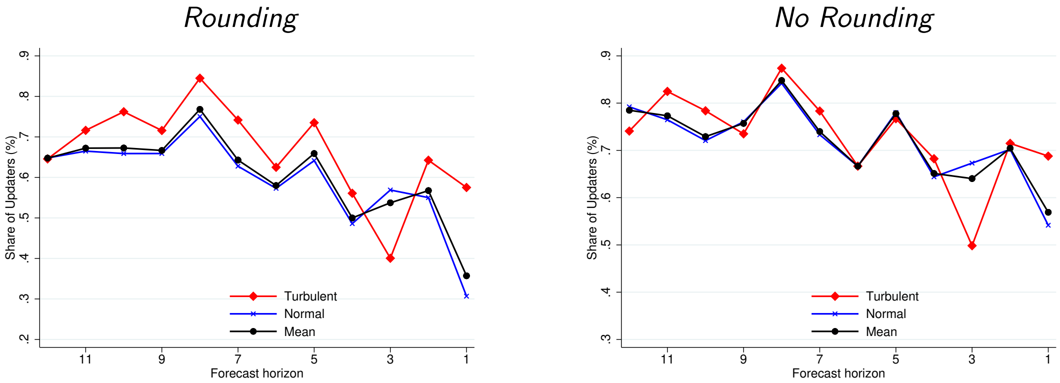
Back Index

- Assess true lumpiness from rounding
- We repeat the analysis for revisions above threshold $\underline{\varphi} \in \{0.01, 0.05, 0.1\}$

C3. Consensus Economics - Revision Frequency

Back Index

- Monthly data, 40 forecasters, three decimal points

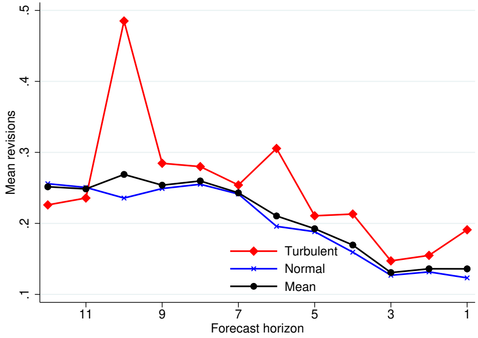


C3. Consensus Economics - Revisions Size

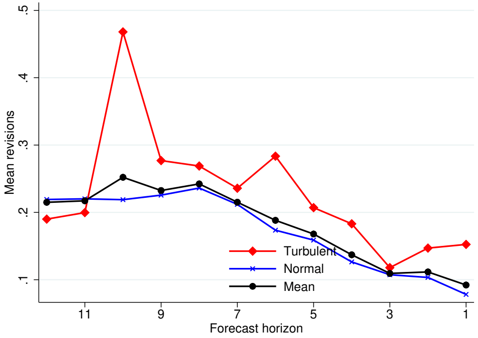
Back Index

- Monthly data, 40 forecasters, three decimal points

Rounding



No Rounding

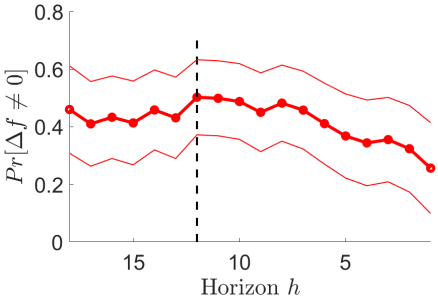


C4. Longer Horizon

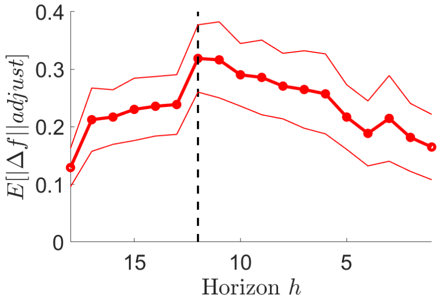
Back Index

- 18 to 13 months ahead (information about future end-of-year inflation)
- 12 to 1 months ahead (inflation is realized)

(a) Frequency of revisions



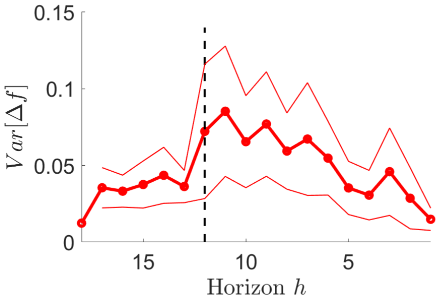
(b) Size of non-zero revisions



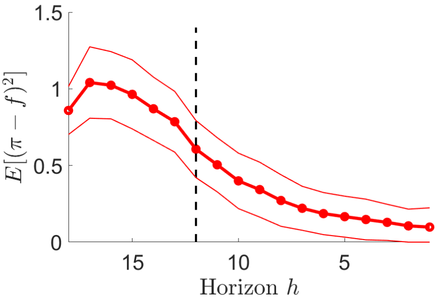
C4. Longer Horizon

Back Index

(a) Variance of revisions



(b) Mean squared error



Equilibrium [Marcet and Nicolini (2003)]

back

- A **restricted perceptions equilibrium** consists of
  - a perceived consensus process $\hat{F}_h$ given by a function g parametrized by (δ, σ_F)

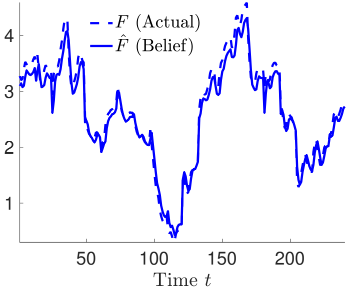
$$\hat{F}_h \;=\; g(\hat{F}_{h+1}, \delta) \;+\; \epsilon_h^{\hat{F}}, \quad \epsilon_h^{\hat{F}} \sim_{i.i.d.} \mathcal{N}(0, \sigma_F^2)$$

  - inflation beliefs $\{\hat{\pi}_h^i\}_{i,h}$ and forecasts $\{f_h^i\}_{i,h}$ for all agents i and horizons h
- such that
  1. Given perceived consensus $\hat{F}_h$, forecast policies $\{f_h^i\}_{i,h}$ are optimal
  2. (δ, σ_F) are such that prediction errors $\epsilon_h^F \equiv F_h - g(F_{h+1}, \delta)$ satisfy:
     - $Cov[\epsilon_h^F, \epsilon_j^F] = 0$
     - $\mathbb{V}ar[\epsilon_h^F] = \sigma_F^2$

Consistency

Consistency of perceived vs. actual consensus back

- Perceived process: $\hat{F}_t = \hat{F}_{t-1} + \eta_t^{\hat{F}} \quad \eta_t^{\hat{F}} \sim_{i.i.d.} \mathcal{N}(0, 0.11^2)$
- Let $\eta_t^F \equiv F_t - F_{t-1}$ be forecast errors of actual consensus under perceived process.
  - $Cov[\eta_h^F, \eta_j^F] = 0$ and $\mathbb{V}ar[\eta_h^F] = 0.11^2$
- Dickey-Fuller tests cannot reject H_0 : F_t is a random walk

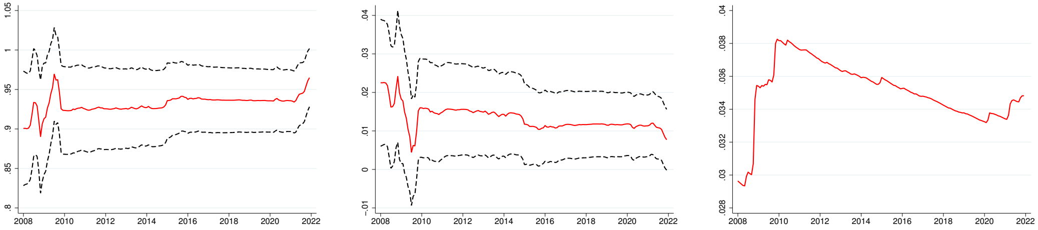


D1. Estimation of Inflation Process π

back

- We estimate (c_x, ϕ_x, σ_x) with a rolling structure.
- Average estimates (across time): $\hat{c}_x = 0.013$, $\hat{\phi}_x = 0.932$ and $\hat{\sigma}_x = 0.036$.

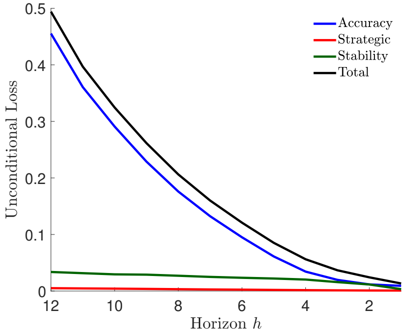
Rolling Estimates AR(1) parameters



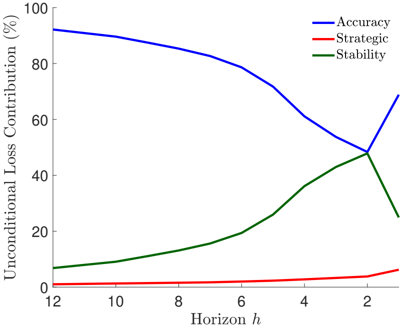
Relative losses from frictions

$$\mathcal{L} = \mathbb{E}\left[\sum_{h=12}^{1} \underbrace{(f_h^i - \pi)^2}_{\text{accuracy}} + r \underbrace{(f_h^i - F_h)^2}_{\text{strategic}} + \underbrace{\kappa \mathbb{1}_{\{f_h^i \neq f_{h+1}^i\}}}_{\text{stability}}\right]$$

(a) Losses across horizon



(b) Relative losses by friction

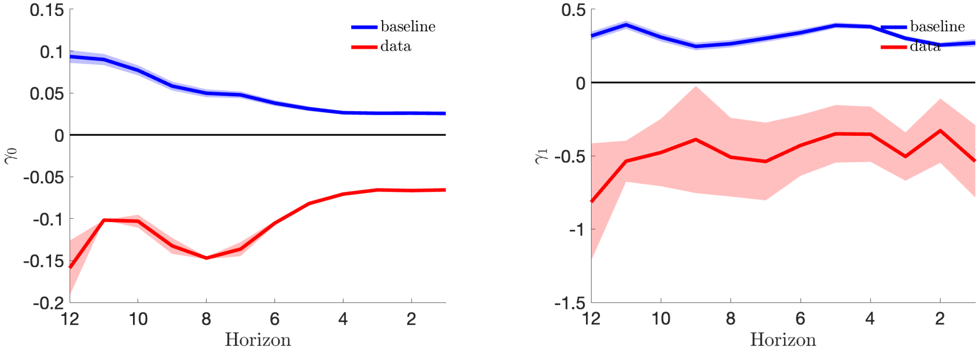


Rationality tests à la Bordalo, et.al, 2020

$$\pi - f_h^i = \gamma_0 + \gamma_1 \left(f_h^i - f_{h+1}^i\right) + \epsilon_h^i$$

(a) No bias

(b) Overreaction to private info



Role of each friction

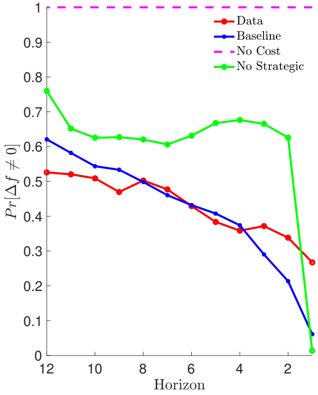
Role of fixed cost κ and strategic concerns r

- We shut down each friction and reestimate parameters

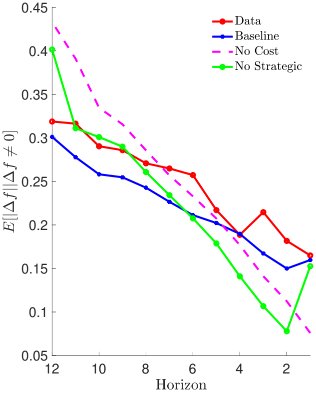
Parameters	**Data**	(1) **Baseline**	(2) **No fixed revision costs**	(3) **No strategic concerns**
κ		0.05	0.00	0.05
r		0.41	-0.38	0.00
σ^2_ζ		0.04	0.05	0.02
Moments				
$\Pr[\Delta f \neq 0]$	0.43	0.42^*	1.00	0.59
$\mathbb{E}[\lvert\Delta f\rvert \mid \Delta f \neq 0]$	0.25	0.22^*	0.25^*	0.22^*
Hazard Slope	-0.04	-0.04^*	N/A	-0.04^*

Role of fixed cost κ and strategic concerns r

(a) Frequency of revisions



(b) Size of non-zero revisions



(c) Hazard Rate

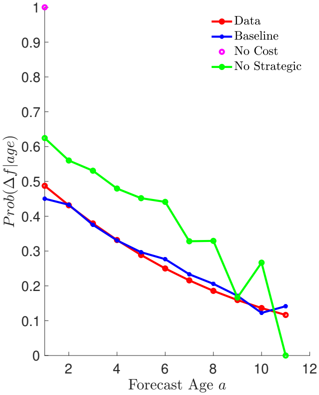
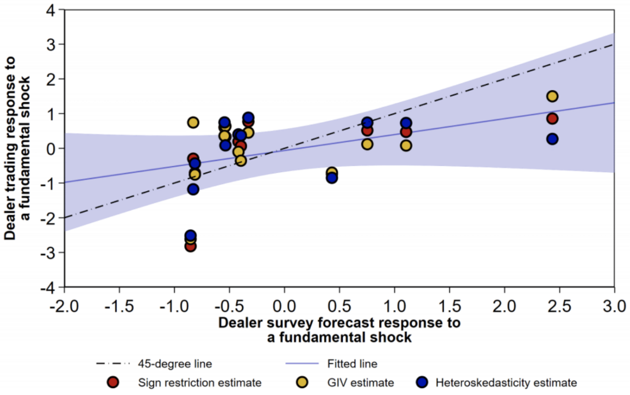


Figure 22 EXPECTATIONS AND HETEROGENEITY IN TRADING

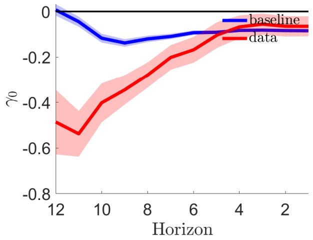


- HIgh correlation between trading activities and inflation expectations in the data.

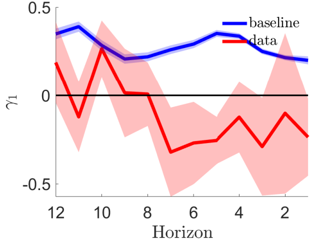
Rationality tests à la Broer and Kolhas, 2022

$$\pi - f_h^i \;=\; \gamma_0 \;+\; \gamma_1\,(f_h^i - f_{h+1}^i) \;+\; \gamma_2\; F_{h+1} \;+\; \epsilon_h^i$$

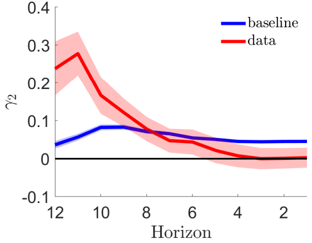
(a) No bias



(b) Overreaction to private info

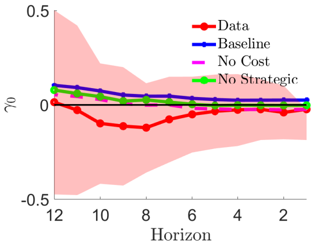


(c) Underreaction to public info

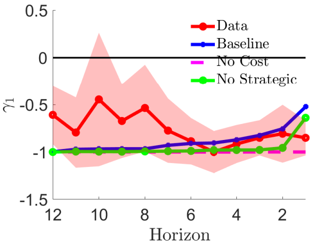


Rationality tests in lumpy model

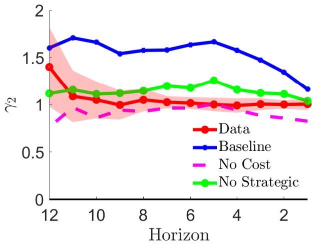
(a) No bias



(b) Overreaction to private info

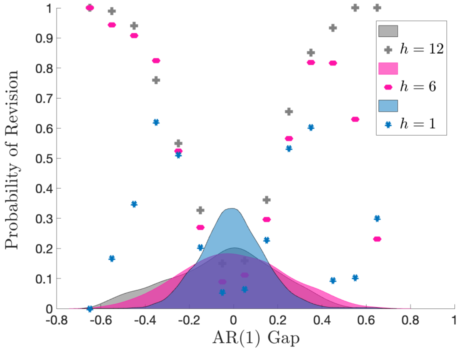


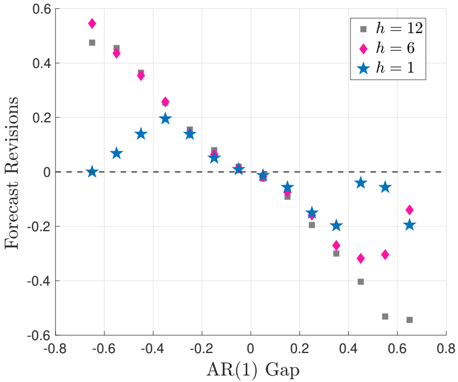
(c) Underreaction to public info



Extensive and intensive margins: Gap to AR(1)

- Gap to AR(1) projection: $b_h^i \equiv f_{h+1}^i - \hat{\pi}_h$





Calibration in turbulent times

- **Normal times**
  - Inflation process $(c_x, \phi_x, \sigma_x^2) = (0.013, 0.932, 0.0013)$
  - Consensus process $\sigma_F = 0.11$

Parameter		Value	Moment	Data	Model
κ	adjustment cost	0.05	$\Pr[\Delta f \neq 0]$	0.43	0.42
r	strategic concerns	0.41	$\mathbb{E}[\|\Delta f\|\|\text{adjust}]$	0.25	0.22
σ_ζ	private noise	0.04	hazard slope	-0.04	-0.04

- **Turbulent times**
  - Inflation volatility $\sigma_x = 0.036 \to \sigma_x' = 1.1 \times 0.036$
  - Consensus process $\sigma_F =$

Parameter		Value	Moment	Data	Model
κ'	adjustment cost	0.10	$\Pr[\Delta f \neq 0]$	0.50	0.48
r'	strategic concerns	-0.35	$\mathbb{E}[\|\Delta f\|\|\text{adjust}]$	0.45	0.51
σ_ζ'	private noise	0.18	hazard slope	-0.04	-0.04

Suggestive evidence of preference for stability

- Horizon overlap:
  - Long term revisions: f^i_{18} to f^i_{12} about π_{t+1}
  - Short term revisions: f^i_6 to f^i_1 about π_t
- Stability: Inactive in short-term while active in long term