

State-Dependent Sticky Expectations: Evidence and Theory

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Motivation

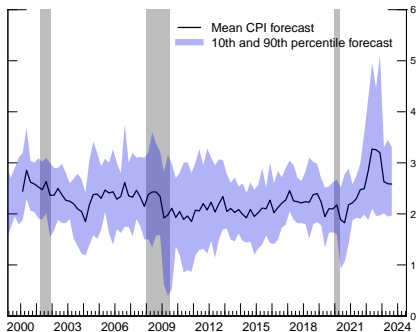


Figure: 12-month ahead SPF forecasts

It was hard enough for experts to form an opinion in the recent inflation episode.

This Paper

How do households process uncertainty around inflation outlook when forming their expectations?

- Conduct RCT with different information treatments, varying information precision of signals
- Test a priori hypothesis of Bayesian updating
- Find households more likely to ignore less precise information

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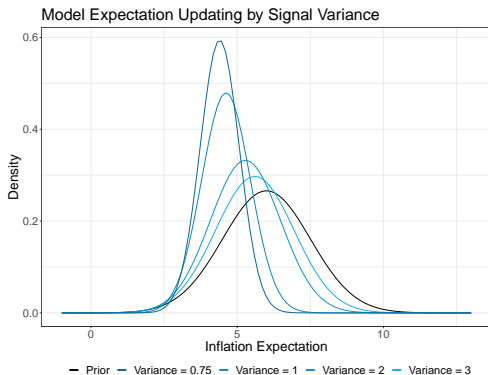
How can we model the intensive margin from the RCT?

- Use Woodford (2008, 2009) rational inattention framework to model inactivity
- Adapt Morales-Jiminez and Stevens (2024) firm problem to household

Related Literature

- RCT Experiments
 - **Households:** Haldane and McMahon (2018); Coibion et al. (2021); Coibion, Gorodnichenko, and Weber (2022); Dräger, Lamla, and Pfajfar (2022); Coibion et al. (2023)
 - **Firms:** Coibion, Gorodnichenko, and Ropele (2020); Coibion, Gorodnichenko, and Kumar (2022)
- Models of Expectation Formation
 - Branch (2004); Pfajfar and Santoro (2010); Coibion and Gorodnichenko (2012, 2015); Malmendier and Nagel (2015); D'Acunto et al. (2021)
- Role of Macroeconomic Uncertainty
 - Uncertainty on economic growth and spending (Coibion, Georgarakos, Gorodnichenko, Kenny and Weber, 2024), Firm decisions (Coibion, Gorodnichenko and Kumar, 2023)

Bayesian Updating



- Update expectations by less as uncertainty increases
- Size of update is increasing function of distance from signal
- Impact of prior dampened as signal uncertainty decreases

Empirical Approach

- Run surveys in December 2022 covering 3000 U.S. households and in August 2023 covering 3800 German households (BOP-HH)
- Conduct a randomized control trial (RCT):
 1. Elicit prior inflation expectations
 2. Give a piece of news about inflation to randomly allocated sub-groups
 3. Elicit posterior inflation expectations
 4. Follow up question

Empirical Approach

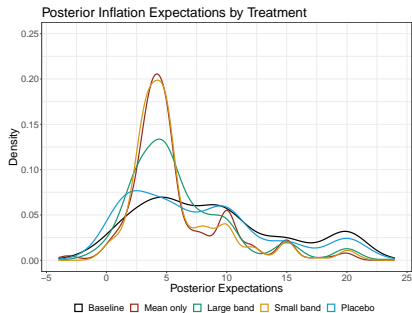
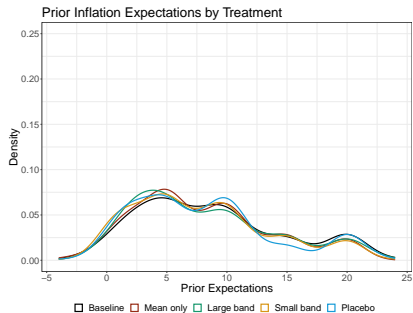
5 treatments:

- No additional news (T_1 , "No Treatment")
- 2022:Q4 SPF mean forecast for CPI inflation (T_2 , "Mean Only")
- Mean + range of responses (T_3 , "Large Band")
- Mean + 20th and 80th percentile responses (T_4 , "Small Band")
- US population growth over the last 3 years (T_5 , "Placebo")

► Details

Also elicit information about inflation news, prior certainty, if provided information was incorporated

Data Overview



► Statistics

► Reviser Densities

Empirical Strategy: Treatment Margins

- Overall Margin:

$$\pi_{i,post}^e = \alpha_0 + \alpha_1 \pi_{i,prior}^e + \beta_1' T_i + \beta_2' T_i \times \pi_{i,prior}^e + \gamma' X_i^c + u_i$$

- Extensive Margin:

$$\mathbf{1}\{\Delta\pi_i^e \neq 0\} = \alpha_0 + \alpha_1 \pi_{i,prior}^e + \beta_1' T_i + \beta_2' T_i \times \pi_{i,prior}^e + \gamma' X_i^c + u_i$$

- Intensive Margin:

$$\pi_{i,post|revised}^e = \alpha_0 + \alpha_1 \pi_{i,prior}^e + \beta_1' T_i + \beta_2' T_i \times \pi_{i,prior}^e + \gamma' X_i^c + u_i$$

Estimate using Huber robust weights, adjusted for population weights

Results

	Overall Margin	Extensive Margin	Intensive Margin
π_{prior}^e	0.9846*** (0.0063)	-0.0140*** (0.0039)	0.4559*** (0.0701)
Mean Only	1.1757*** (0.1878)	0.3075*** (0.0685)	1.2801*** (0.4029)
Large Band	0.1210 (0.1192)	0.0721 (0.0678)	1.8714*** (0.4306)
Small Band	1.7791*** (0.2227)	0.2887*** (0.0671)	1.6181*** (0.3984)
Placebo	-0.1745* (0.1028)	0.0746 (0.0639)	-0.4253 (0.4629)
Mean Only $\times \pi_{prior}^e$	-0.3659*** (0.0367)	0.0194*** (0.0063)	-0.2456*** (0.0740)
L. Band $\times \pi_{prior}^e$	-0.0324** (0.0139)	0.0223*** (0.0063)	-0.3296*** (0.0748)
Sm. Band $\times \pi_{prior}^e$	-0.4827*** (0.0423)	0.0220*** (0.0062)	-0.2681*** (0.0740)
Placebo $\times \pi_{prior}^e$	0.0082 (0.0096)	0.0042 (0.0061)	0.0647 (0.0849)
Constant	0.1577 (0.2304)	0.1092 (0.1034)	1.0651 (0.9595)
N	1467	1609	733
R^2	0.935	0.197	0.414
Mean Only = L. Band	0.000	0.001	0.057
Sm. Band = L. Band	0.000	0.003	0.399
Mean Only = L. Band (int)	0.000	0.682	0.027
Sm. Band = L. Band (int)	0.000	0.960	0.090

Results: Intensive Margin

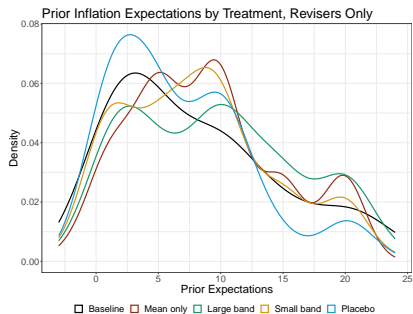


Figure: Prior belief kernel density

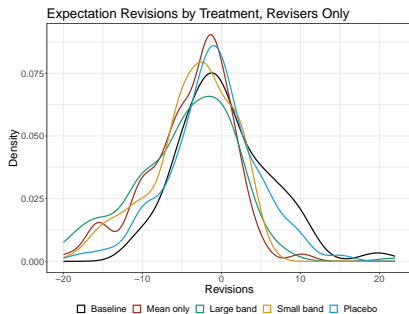


Figure: Revision kernel density

► Binned Scatter Plots

Modeling the Extensive Margin

Bayesian model predicts posterior difference between groups in intensive margin

RCT results imply the extensive margin drives the results

How can we model this?

Rational Inattention

Sims (2010): “Everyone ignores or reacts sporadically and imperfectly to some information that they ‘see.’ I page through the business section of the New York Times most mornings, ‘seeing’ charts and tables ... [b]ut most days I take no action at all based on the information I have viewed.”

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In our RCT:

- Less precise signal \implies more costly to process
- Prior far from signal \implies more likely to update

Rational Inattention

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Woodford (2009): extends model to dynamic firm pricing problem

Morales-Jiminez and Stevens (2024): extension of Woodford (2009), more tractable

Warmup: Sticky Expectations

Fixed, exogenous sticky expectations HH problem:

$$V(\pi^{HH}, b) = \max_{c, n, b'} \left\{ u(c, n) + \beta \left[\Lambda V(\pi'', b') + (1 - \Lambda) V(\pi^{HH}, b') \right] \right\}$$

$$pc + qb' = wn + b$$

Sticky expectations Euler equation:

$$x_t = E[x_{t+1}] - \frac{1}{\sigma} \left(i_t - \underbrace{(\Lambda E[\pi_{t+1}] + (1 - \Lambda)\pi_{t-1}^{HH})}_{\equiv \pi_t^{HH}} - r_t^n \right)$$

Rationally Inattentive Households

Given $\bar{\Lambda}$, household chooses Bernoulli RV $\Lambda(\pi^e, b)$ that solves

$$V_{\Lambda}(\pi^{HH}, b) = \max_{\Lambda} \{ \Lambda(V(\pi', b) - \kappa) + (1 - \Lambda)V(\pi^{HH}, b) - \theta D(\Lambda || \bar{\Lambda}) \}$$

where

$$D(\Lambda || \bar{\Lambda}) = \Lambda \log \left(\frac{\Lambda}{\bar{\Lambda}} \right) + (1 - \Lambda) \log \left(\frac{1 - \Lambda}{1 - \bar{\Lambda}} \right)$$

$$V(\pi^e, b) = \max_{c, n, b'} \left\{ \frac{c^{1-\sigma}}{1-\sigma} - \frac{n^{1+\varphi}}{1+\varphi} + \beta V_{\Lambda}(\pi^e, b') \right\} \text{ s.t.}$$

$$pc + qb' \leq b + wn$$

$$p' = \pi^e p$$

Optimal Inattention

FOC w.r.t. Λ :

$$\theta \left[\log \left(\frac{\Lambda}{\bar{\Lambda}} \right) - \log \left(\frac{1 - \Lambda}{1 - \bar{\Lambda}} \right) \right] = V(\pi', b) - \kappa - V(\pi^e, b)$$

- $\theta \rightarrow \infty$: collapse to sticky expectations with $\Lambda = \bar{\Lambda}$,
- $\theta \rightarrow 0$: collapse to menu cost

2-Period Partial Equilibrium Example

$$V_{\Lambda}(\pi^{HH}) = \max_{\Lambda} \left\{ \Lambda(V(\pi') - \kappa) + (1 - \Lambda)V(\pi^{HH}) - \theta D(\Lambda || \bar{\Lambda}) \right\}$$

where

$$V(\pi^e) = \frac{c^{1-\sigma}}{1-\sigma} + \beta \frac{(c')^{1-\sigma}}{1-\sigma}$$

$$c' = \frac{(w - c)(1 + r) + w}{\pi'}$$

and c maximizes

$$\frac{c^{1-\sigma}}{1-\sigma} + \beta \frac{\tilde{c}^{1-\sigma}}{1-\sigma} \text{ s.t.}$$

$$c + \frac{1}{1+r}b' = w; \quad \pi^{HH}\tilde{c} = w + b'; \quad b' \geq -w$$

2-Period Partial Equilibrium Example

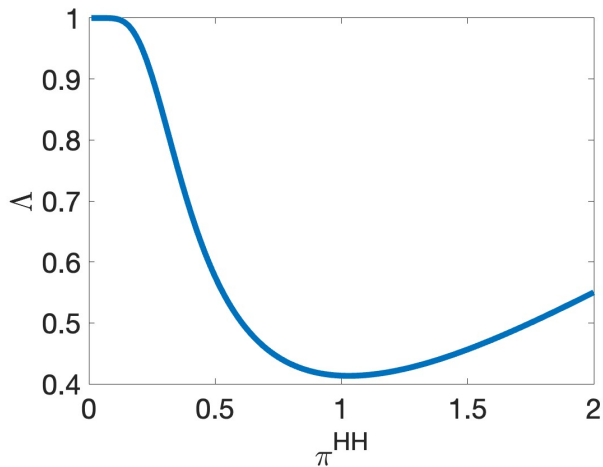


Figure: Optimal Λ , $\pi' = 1.03$

Wrapping Up

Conclusions

- RCT implies uncertainty around forecasts matters for households, particularly in extensive margin
- Bayesian model predicts difference should be driven by intensive margin
- Rationally inattentive model can deliver extensive margin

Next steps

- Solve the model!
- Study implications for inflation dynamics

Thank you for your attention!

Appendix: Empirical Approach

- Your previous inflation expectation was $[\pi_{i,prior}^e]$.
Would you like to adjust your expectations base on the following information?
- ... [Mean Only] According to a mean response in the Survey of Professional Forecasters, inflation over the next 12 months will be 3.7 percent.
- ... [Large Band] According to a mean response in the Survey of Professional Forecasters, inflation over the next 12 months will be 3.7 percent, where the range of responses was between 1.7 percent and 7.1 percent.
- ... [Small Band] According to a mean response in the Survey of Professional Forecasters, inflation over the next 12 months will be 3.7 percent, where most responses fell between 2.9 percent and 4.8 percent.
- ... [Placebo] The U.S. population grew 1.2 percent over the last three years.

Appendix: Data Overview

Demographic breakdown by treatment group

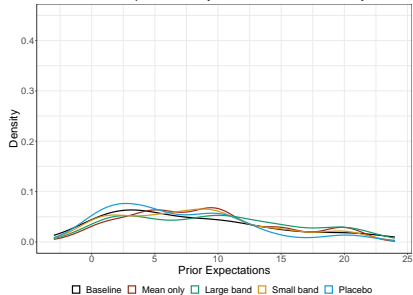
	Female	Over 54	Mid. inc.	High inc.	High school	Voc.	Uni.
No information	0.55	0.19	0.28	0.09	0.35	0.14	0.49
Mean only	0.57	0.19	0.26	0.11	0.34	0.16	0.48
Large Band	0.57	0.16	0.24	0.11	0.35	0.18	0.45
Small Band	0.54	0.19	0.28	0.11	0.33	0.19	0.48
Placebo	0.56	0.17	0.27	0.10	0.27	0.19	0.53
Average	0.56	0.18	0.27	0.10	0.33	0.17	0.49

Appendix: Conscious Bands

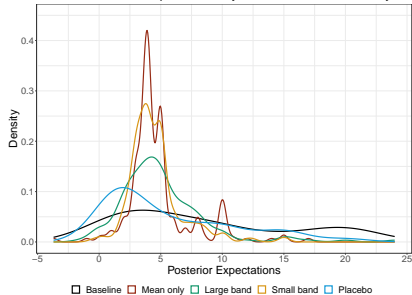
	Overall	Extensive	Intensive
Large Band	0.5386* (0.3252)	-0.0716 (0.0604)	0.5183 (0.3595)
Considered Band	-0.1249 (0.2637)	0.4043*** (0.0578)	0.1643 (0.2278)
L. Band \times Considered Band	-0.7235* (0.3829)	-0.1467* (0.0797)	-0.5632 (0.4113)
<i>N</i>	628	658	340
<i>R</i> ²	0.065	0.203	0.097

Appendix: Data Overview

Prior Inflation Expectations by Treatment, Revisers Only



Posterior Inflation Expectations by Treatment, Revisers Only



▶ Back

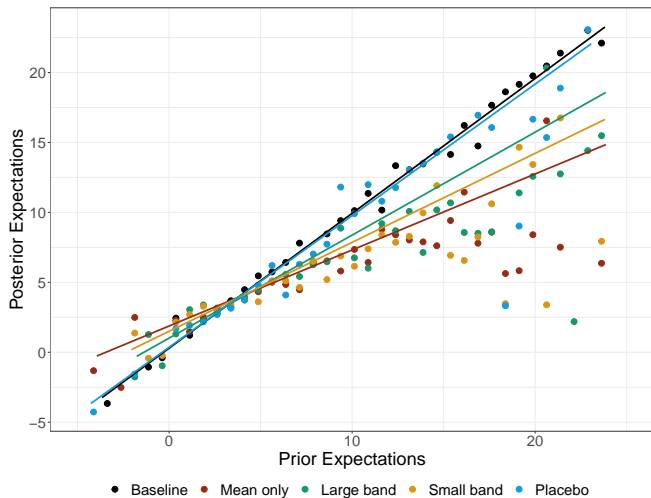
Appendix: Summary Statistics

	$\pi_{i,prior}^e$	$\pi_{i,posterior}^e$	$\pi_{i,prior,revisers}^e$	$\pi_{i,posterior,revisers}^e$	Fraction revised
No Treatment					
Mean	8.28	8.21	6.18	5.90	0.24
Median	8.00	8.00	5.00	4.00	
Std. Dev.	5.61	5.61	5.91	5.80	
Mean Only					
Mean	7.61	5.55	7.88	4.61	0.63
Median	6.70	5.00	8.00	4.00	
Std. Dev.	5.40	3.77	5.74	2.61	
Large Band					
Mean	8.31	6.55	8.94	5.06	0.45
Median	7.50	5.00	8.00	4.20	
Std. Dev.	5.85	4.73	6.47	3.52	
Small Band					
Mean	7.98	5.84	8.27	4.85	0.62
Median	8.00	5.00	8.00	4.50	
Std. Dev.	5.66	3.84	6.00	2.41	
Placebo					
Mean	7.69	7.38	6.90	5.91	0.32
Median	7.00	6.00	5.00	3.50	
Std. Dev.	5.45	5.45	5.63	5.43	
Total					
Mean	7.98	6.70	7.89	5.08	0.45
Median	7.00	5.00	8.00	4.00	
Std. Dev.	5.60	4.83	6.01	3.70	

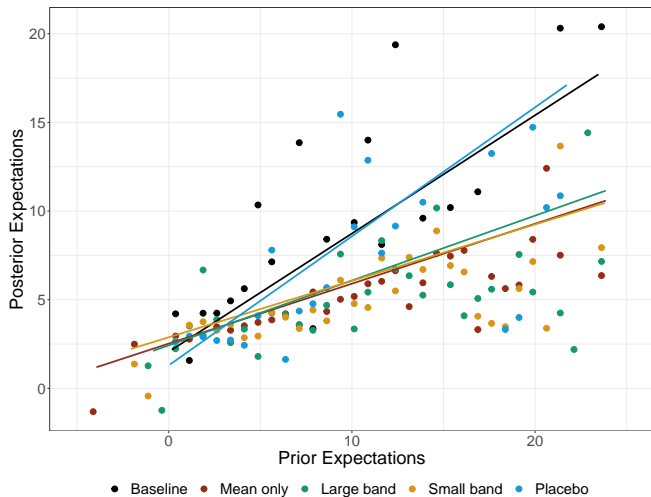
Appendix: Variance of Prior Expectation

Probability of Updating		
	Population Weights	Huber Weights
π_{prior}^e	-0.000 (-0.14)	0.006** (3.02)
Prior uncertainty	0.070 (1.24)	0.221*** (5.26)
Mean Only	0.388*** (8.50)	0.523*** (14.96)
Large Band	0.213*** (4.78)	0.362*** (10.47)
Small Band	0.385*** (8.52)	0.510*** (14.89)
Placebo	0.087* (1.98)	0.191*** (5.51)

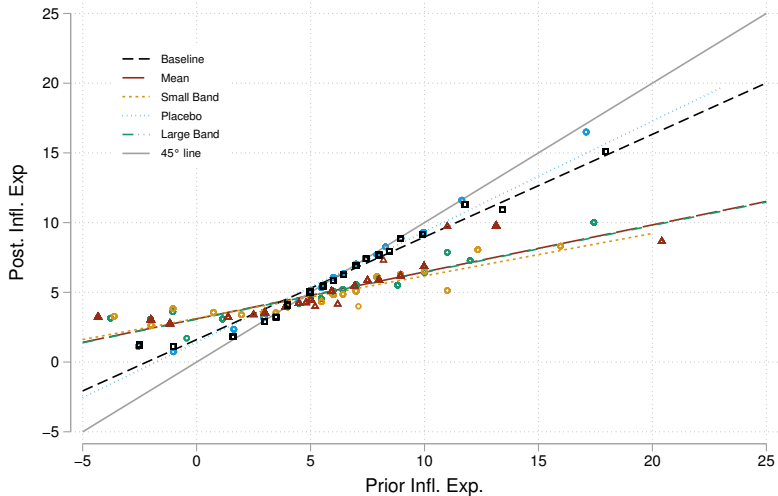
Appendix: Overall Margin - Scatterplot



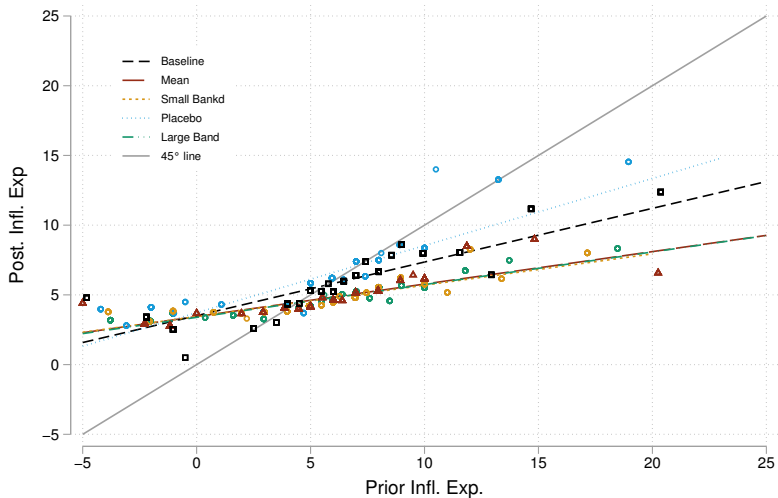
Appendix: Intensive Margin



Appendix: BOP-HH, Overall Margin



Appendix: BOP-HH, Intensive Margin



Appendix: Sticky Expectations

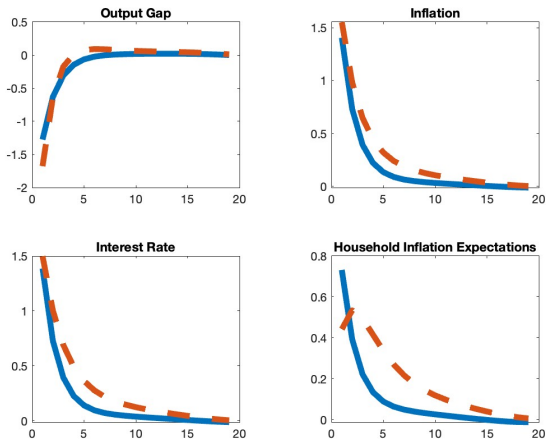


Figure: Inflation Shock Impulse Response