Inflation Expectations and Inflation Surprises

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Federal Reserve Board

Introduction

High inflation currently a serious challenge.

- Inflation very hard to forecast.

In order to guide monetary policy, policymakers instead focus on the anchoring of inflation expectations. Unfortunately, two difficulties:

1. Crucial to understand nature of expectations formation.
   - Significant evidence against full-information rational expectations (Coibion and Gorodnichenko, 2015), but what to replace it with is active research area.
2. Macroeconomic link between inflation expectations and realized inflation not clear either theoretically or empirically (Werning, 2022; Rudd, 2022).

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New approach: examine how inflation expectations respond to inflation surprises.

- Use unexpected component of Consumer Price Inflation prints as inflation "news" surprise, measure response of long-run inflation expectations.
- Consistent with growing literature documenting unanchored long-run inflation expectations (Carvalho et al., 2023; Jørgensen and Lansing, 2021), find that both households' and professional forecasters' expectations respond to surprises.
- But, response is not linear! Better characterized by power relationship.
  - Consistent with rational inattention models (Gabaix, 2019), small inflation shocks do not affect inflation expectations.

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Turn to the macroeconomic implications of power relationship for realized inflation.

- Stylized partial equilibrium model shows that power response of inflation expectations to inflation surprises predicts a non-linear interaction term affecting future inflation.
- Mapping this prediction to the data, find that revisions to longer-run inflation expectations in response to inflation surprises determine inflation persistence and lead to non-linear increases in realized inflation.
- Throughout empirical analysis, find evidence of asymmetries.
  - Diminished response of both inflation expectations and realized inflation to disinflationary shocks (Baqaee, 2020; Gorodnichenko and Sergeyev, 2021).

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Inflation Surprise

Use surprise component of CPI releases as inflation shock.

$$shock_t := \text{Actual CPI}_t - \text{Expected CPI}_t \tag{1}$$

- Expected CPI is from a survey of professional forecasters taken the day before each release, surprise orthogonal to agents expectations.
- CPI is measured as the month-over-month change in the price level.

Inflation Surprise

Table: OLS Regressions of (Standardized) Surprise and Actual Inflation

	Change in Log CPI	
	(1)	(2)
Dependent Variable	Monthly	Quarterly
Unanticipated Component	0.98***	1.56***
	(0.115)	(0.233)
Constant	0.39***	0.75***
	(0.012)	(0.042)
Observations	533	160
R-squared	0.20	0.24

Heteroskedasticity-robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Sample: 1977:m10-2023:m3.

Effects on Inflation Expectations

Measure effect of inflation surprises on expectations using local projections

$$\pi_t^e = \alpha + \beta_1 shock_t + \beta_2 shock_t^2 + \beta_3 shock_t^3 + \sum_{i=1}^{3} \phi_i \pi_t^e + \epsilon_t \tag{2}$$

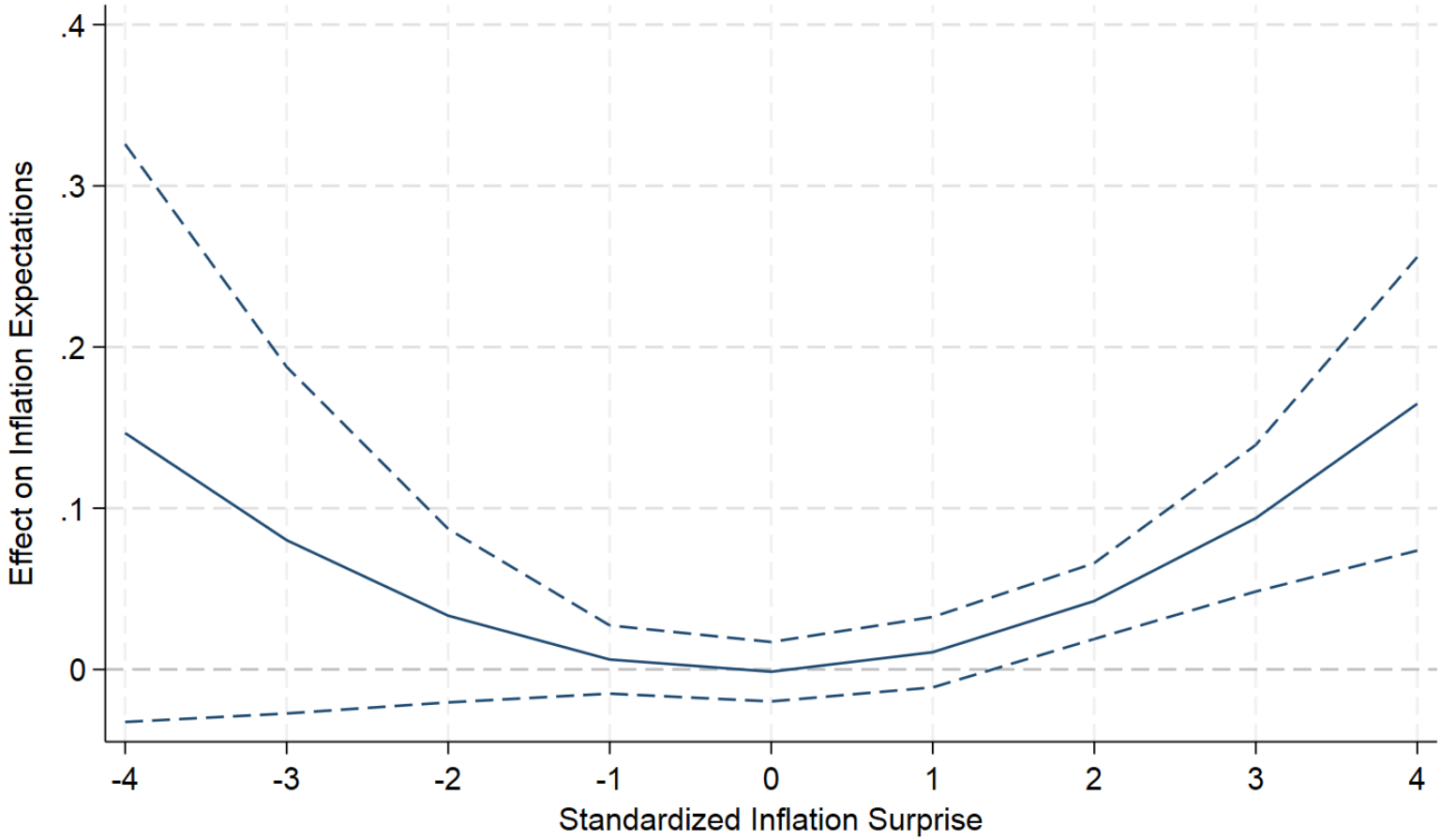
- π_t^e is the median long-run inflation expectation from households (University of Michigan survey) or professional forecasters (Survey of Professional Forecasters).
- $shock_t$ is the inflation surprise corresponding to period t.

Table: Effects of Surprise Inflation on Inflation Expectations

Dependent Variable	Household Survey 5-10 Year Expectations		SPF 1-10 Year Expectations	
	(1)	(2)	(3)	(4)
shock	0.0114	-0.0036	0.0221***	0.0175**
	(0.0087)	(0.0112)	(0.0078)	(0.0077)
$shock^2$		-0.0000		0.0054**
		(0.0045)		(0.0027)
$shock^3$		0.0035**		
		(0.0016)		
Constant	0.1674***	0.1623**	0.1242**	0.1190**
	(0.0632)	(0.0641)	(0.0580)	(0.0572)
F-test		(1) Rejected		(3) Rejected
p-value		0.0206**		0.0483**
Observations	394	394	126	126
R-squared	0.89	0.89	0.95	0.95
Frequency	Monthly	Monthly	Quarterly	Quarterly

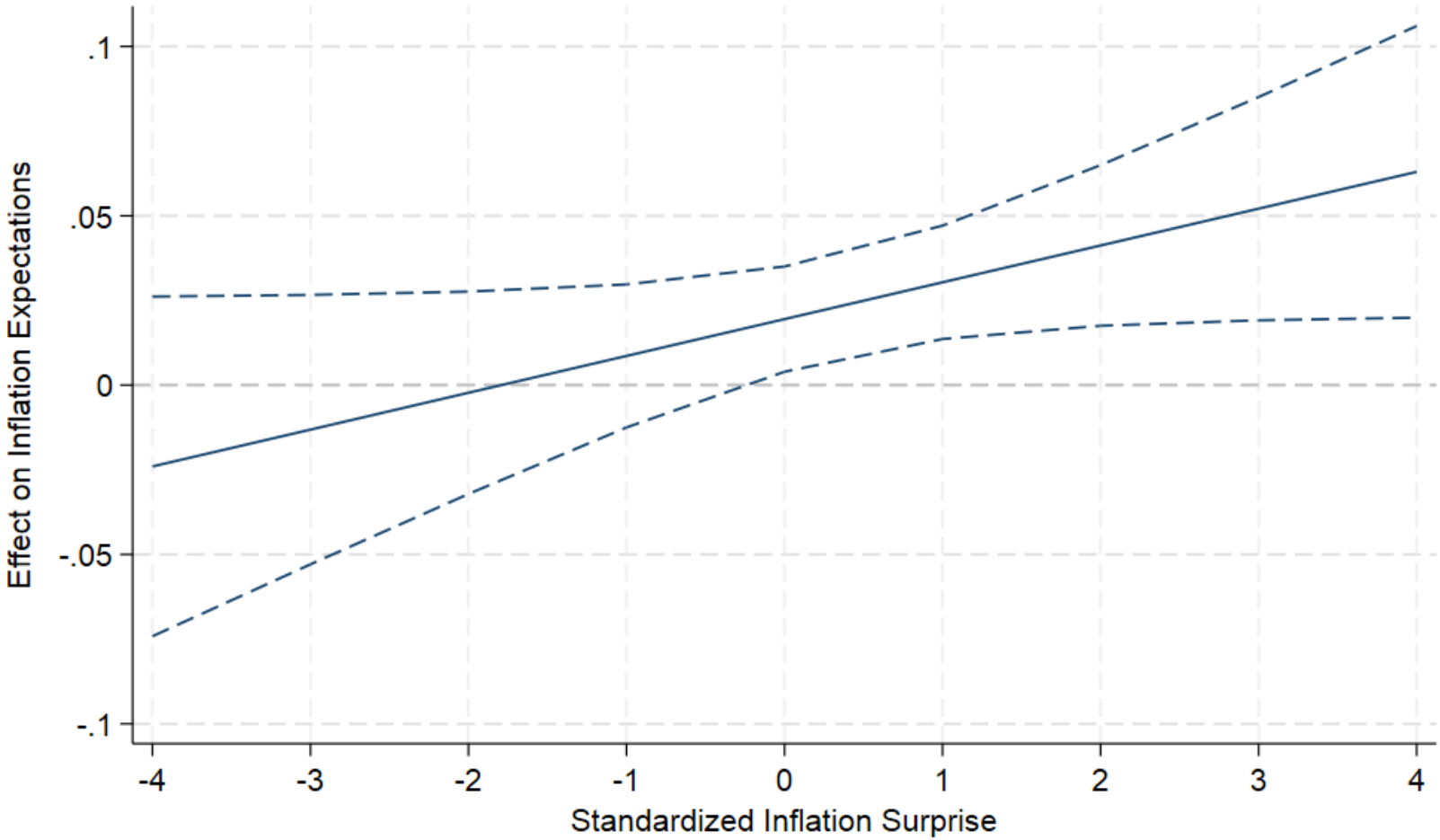
Heteroskedasticity-robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Figure: Marginal Effect of Shock on Households' Inflation Expectations



Sample: 1981:M2-2022:M2. 90% confidence intervals indicated by dashed line.

Figure: Marginal Effect of Shock on Professional Forecasters' Inflation Expectations



Sample: 1992:Q3-2022:Q2. 90% confidence intervals indicated by dashed line.

Illustrative Model

Consider a two-period model. Agent receives a signal η_t in period 0 and inflation is assumed to follow

$$\pi_0 = \eta_0,\ \eta_0 \sim N(0,1) \tag{3}$$

- In the spirit of a hybrid New-Keynesian Phillips curve, period 1 inflation process is assumed to follow

$$\pi_1 = \lambda\rho\eta_0 + (1-\lambda)\mathbb{E}[\pi_1]. \tag{4}$$

- $0 < \lambda < 1$ determines degree to which process is backward-looking.
- $0 < \rho < 1$ determines degree of inflation persistence.

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Illustrative Model

Under full-information rational expectations,

$$\begin{aligned} \mathbb{E}[\pi_1] &= \pi_1 && (5) \\ &= \lambda\rho\eta_0 + (1-\lambda)\mathbb{E}[\pi_1] && (6) \\ &= \rho\eta_0 && (7) \end{aligned}$$

- Period 1 inflation equals $\rho\eta_0$, and inflation expectations have linear relationship with signal η_0 and linear effect on inflation.

Illustrative Model

- If inflation expectations affect inflation but deviate from full-information rational expectations, inflation will move in accordance with the expectation of inflation that agents take away from the signal η_t.

$$\pi_1 = \lambda\rho\eta_0 + (1-\lambda)\mathbb{E}[\pi_1|\eta_0] \tag{8}$$

- One must then know how expectations formation $\mathbb{E}[\pi_1|\eta_0]$ occurs. In accordance with the data, I assume inflation expectations have a power relationship with the signal,

$$\mathbb{E}[\pi_1|\eta_0] = \eta^{\phi},\ \phi > 1 \tag{9}$$

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- The inflation process then follows

$$\pi_1 = \lambda\rho\eta_0 + (1-\lambda)\eta_0^{\phi} \tag{10}$$

- The effect of the signal will be

$$\frac{\partial \pi_1}{\partial \eta_0} = \lambda\rho + (1-\lambda)\phi\frac{\mathbb{E}[\pi_1|\eta_0]}{\eta_0} \tag{11}$$

$$= \lambda\rho + (1-\lambda)\frac{\partial \mathbb{E}[\pi_1|\eta_0]}{\partial \eta_0} \tag{12}$$

- Notice that if $\mathbb{E}[\pi_1|\eta_0] = 0$ for disinflationary shocks, effects of disinflationary shocks on inflation will be attenuated.

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Mapping Prediction to the Data

- Rewriting the theoretical prediction,

$$\frac{\partial \pi_1}{\partial \eta_0} = \lambda\rho + (1-\lambda)\frac{\partial \mathbb{E}[\pi_1|\eta_0]}{\partial \eta_0} \tag{13}$$

- We can test for such a term using the following regression,

$$\pi_t = \alpha + \beta\eta_{t-1} + \xi\mathbb{E}[\pi_t] + \gamma \cdot \eta_{t-1} \cdot \mathbb{E}[\pi_t] + \rho_h \pi_{t-1} + \epsilon_t. \tag{14}$$

- Denoting $\widetilde{\mathbb{E}[\pi_t|\eta_{t-1}]}$ as the revision in inflation expectations, regression implies

$$\frac{\partial \pi_t}{\partial \eta_{t-1}} = \beta + \gamma\widetilde{\mathbb{E}[\pi_t|\eta_{t-1}]}. \tag{15}$$

- According to (13), one should estimate $\hat{\beta} = \lambda\rho$ and $\hat{\gamma} = (1-\lambda)$ on a period-by-period basis.
  - If $\gamma > 0$, $\widetilde{\pi}_t^e$ increases persistence of η_{t-1} and *amplifies* effect on future inflation.

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Empirical Approach

- Use revision in survey expectations, $\widetilde{\pi_t^e}$ as measure of $\widetilde{\mathbb{E}[\pi_t]}$.
- Test for interaction term with local projections, horizons indexed by h

$$\pi_{t+h} = \alpha_h + \beta_h shock_t + \xi_h \widetilde{\pi_t^e} + \gamma_h \cdot shock_t \cdot \widetilde{\pi_t^e} + \rho_h \pi_{t-1} + \epsilon_t^h.$$

- β_h captures dynamic effect of surprise inflation ($shock_t$) on π_{t+h}, the CPI inflation rate at horizon h.
- ξ_h captures effect of a revision to longer-run inflation expectations, denoted by $\widetilde{\pi_t^e}$.
- Interaction term γ_h captures effect of the inflation shock conditional on a revision to inflation expectations.
- Include coefficients for many lags of π_t, $shock_t$, and unemployment rate.

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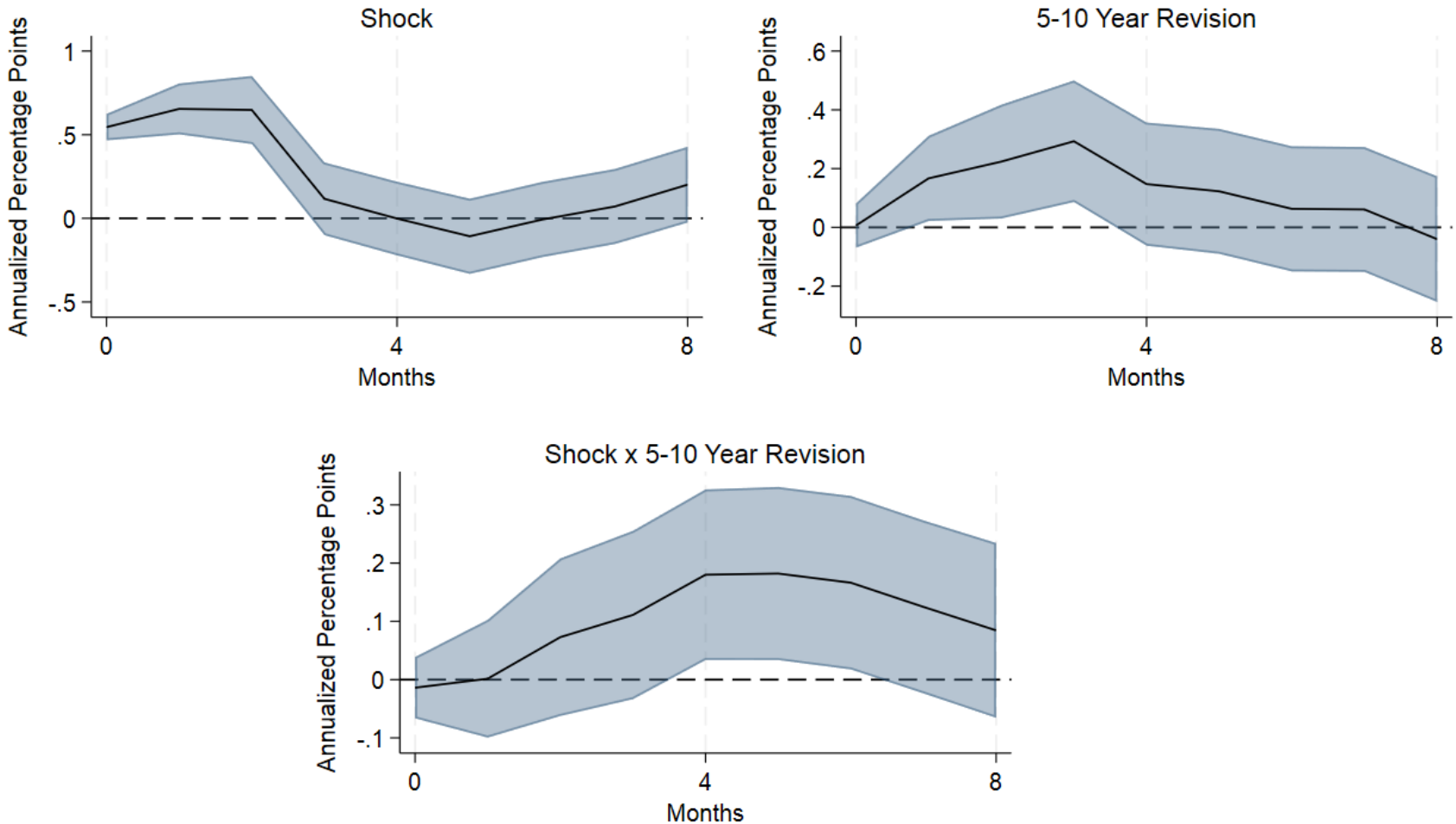
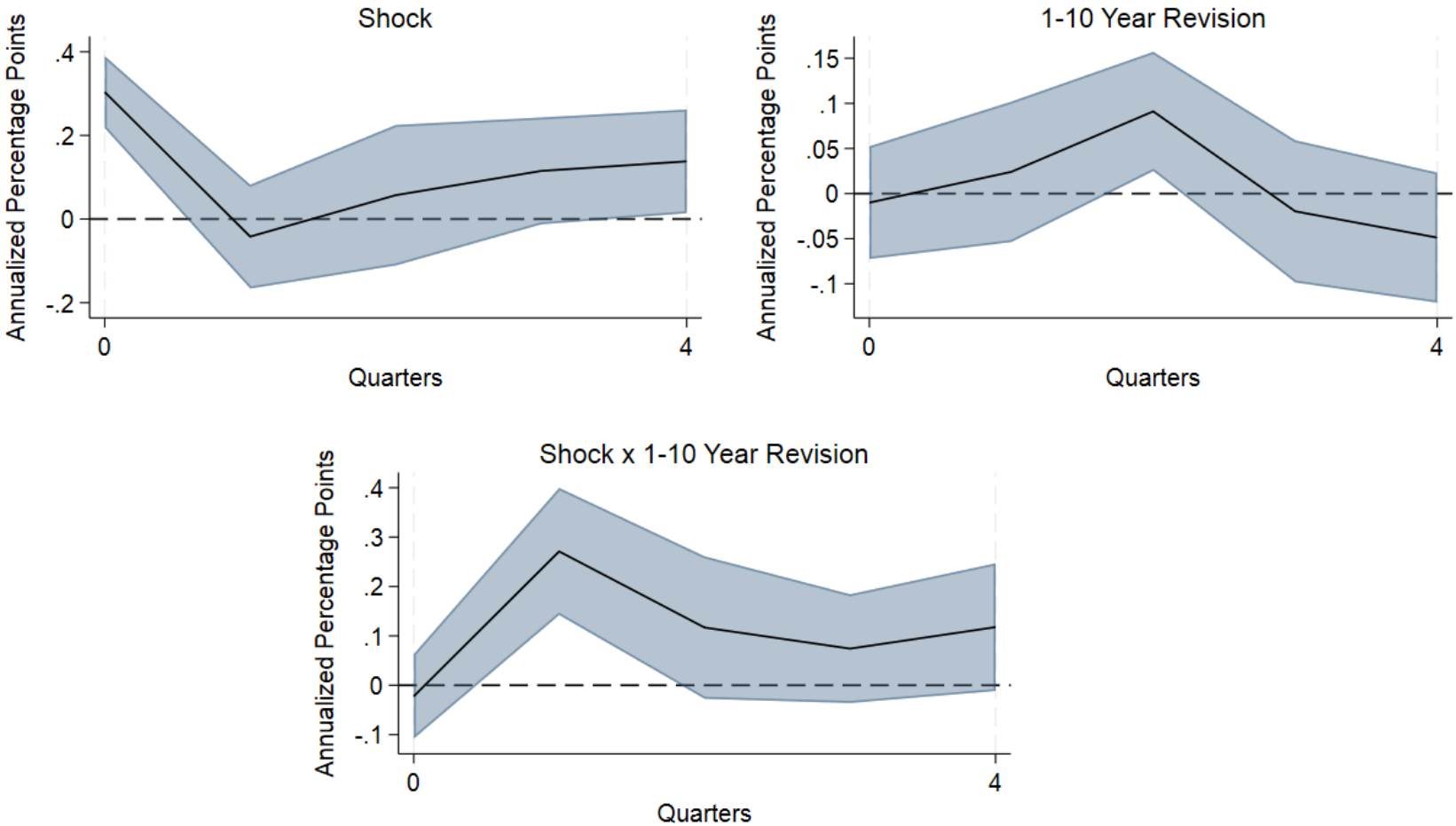
Figure: Realized Inflation Response to Standardized Unexpected Inflation and Households' Standardized 5-10 Year Revision in Inflation Expectations



Sample: 1981:M2-2022:M2. 90% confidence intervals indicated by shaded areas. 5-10 year revision is the median monthly revision in households' survey expectation of inflation over the following 5-10 years.

Figure: Realized Inflation Response to Standardized Inflation Shock and SPF Standardized 1-10 Year Revision in Inflation Expectations



Sample: 1983:Q1-2022:Q1. 90% confidence intervals indicated by shaded areas. 1-10 year revision is the mean quarterly revision in SPF inflation expectations over the following 1-10 years.

Marginal Effects: Full Sample

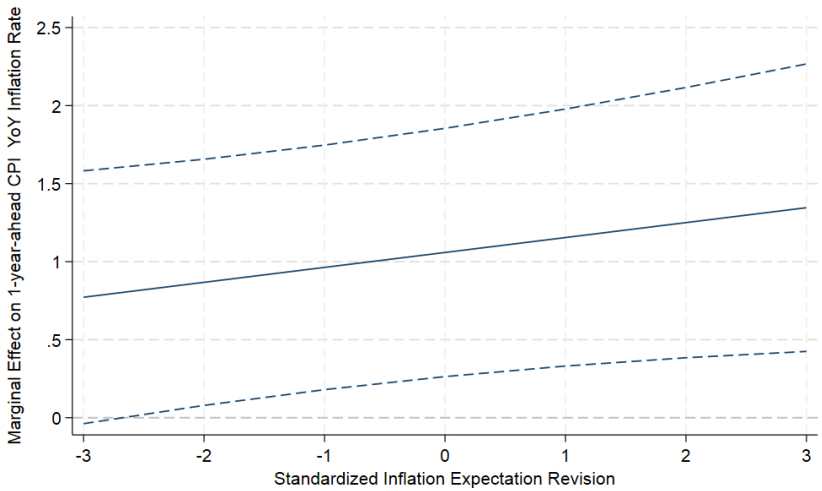


Figure: Households

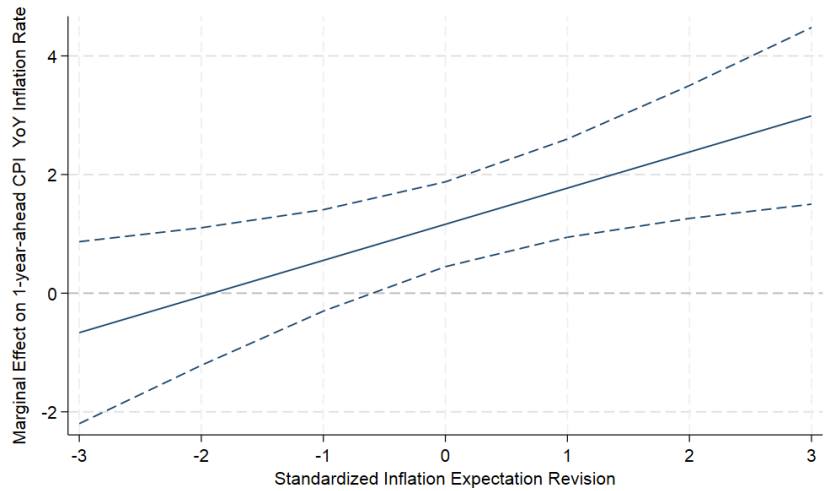


Figure: Professional Forecasters

95% confidence intervals indicated by shaded areas.

Marginal Effects: Only Negative Shocks

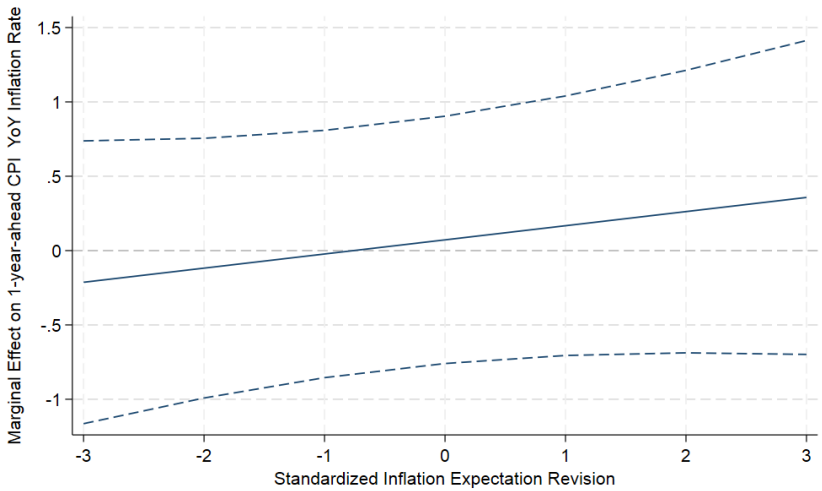


Figure: Households

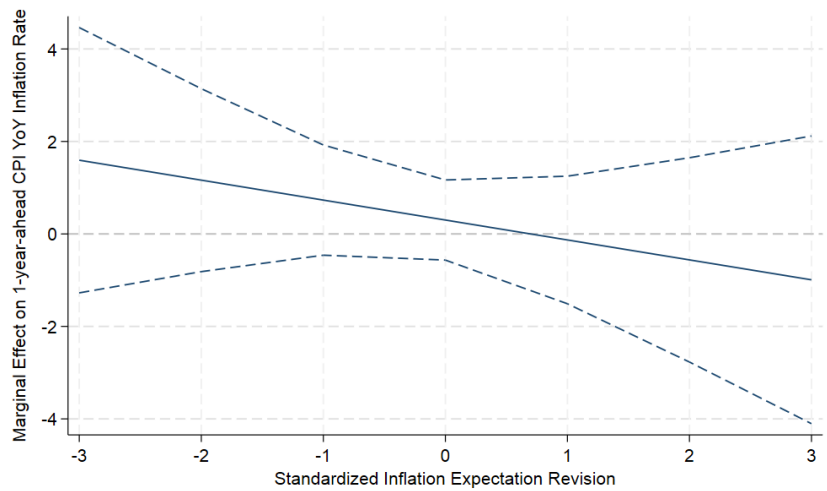


Figure: Professional Forecasters

95% confidence intervals indicated by shaded areas.

Conclusion

Through a power relationship, revisions to longer-run inflation expectations determine the effect of surprise inflation.

- Large inflation shocks lead to large upwards long-run revisions, amplifying effects on realized inflation.
- Downwards revisions in response to unanticipated disinflation have little effect.

Conclusion

Policy implications: consistent with the view that

- unanchored long-run inflation expectations can lead to large increases in realized inflation,
- may be difficult to engineer disinflation through downwards revisions in long-run inflation expectations.

Theoretical implications:

- evidence in favor of models of inflation determination that feature imperfect information and learning about the central bank's long-run inflation target (Jørgensen and Lansing, 2021; Carvalho et al., 2023) inflation.

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