ESTIMATING THE RISE IN EXPECTED INFLATION FROM HIGHER ENERGY PRICES

Paula Patzelt and Ricardo Reis
LSE

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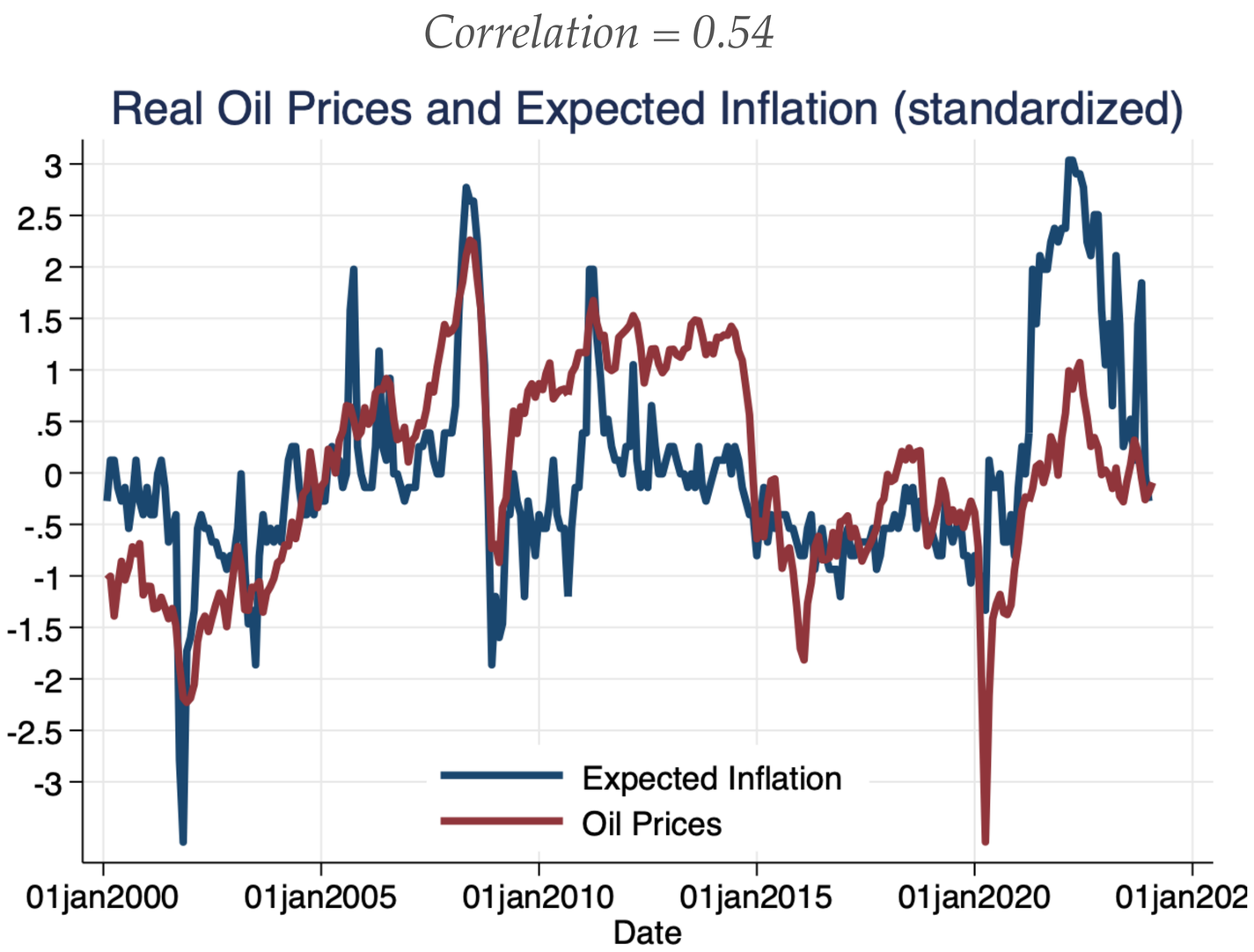
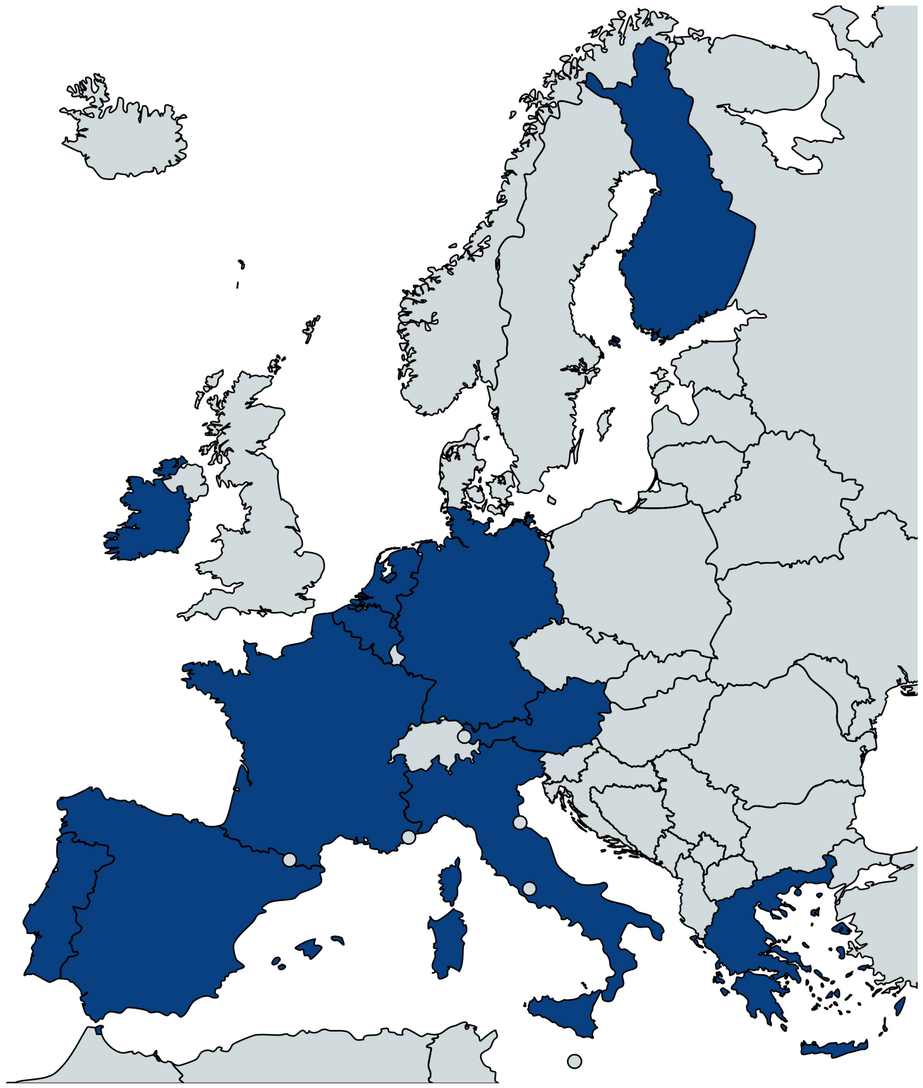
Reykjavík

Questions and time series variation



- Energy prices (gas) are one of the top two determinants of people's information and expectations of inflation. (D'Acunto et al, 2023)
- Do people over-react to them or are they inattentive?
- Further argument to see through them or heed to warning signals?
- This paper: use cross-regional variability to identify it

Cross-section variation: expected inflation



- EA consumer expectations survey: 9,000-22,000 respondents, 2020:4-2023:12, 11 countries, expected 12-months ahead

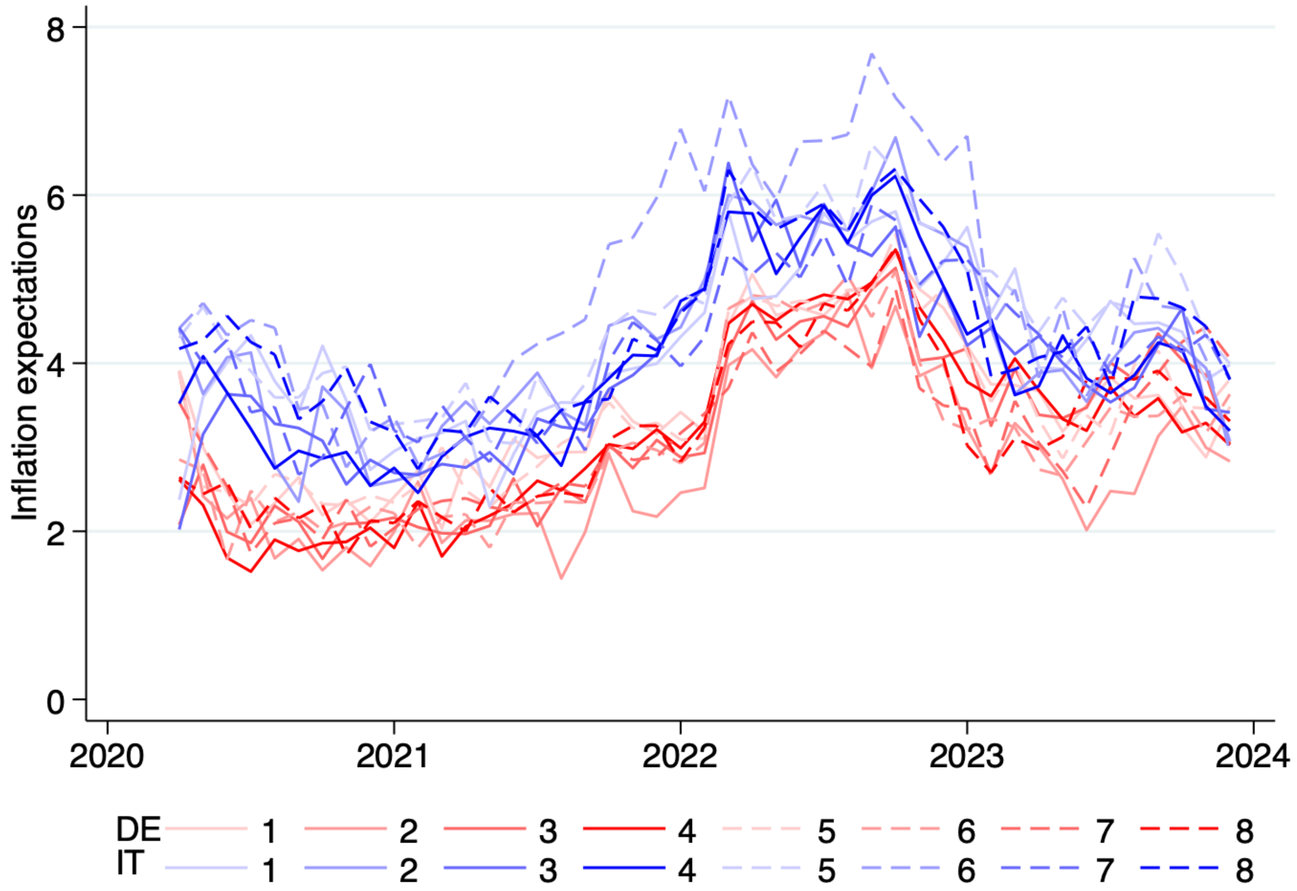
- $\pi^{e}_{i,c,g,t}$ expected inflation person *i*, country *c*, group *g*, month *t*

Eight demographic groups *g* crossing

- gender (male/female)
- income bracket (above/below 60th percentile)
- education (college/below)

Variation in expected inflation in the data

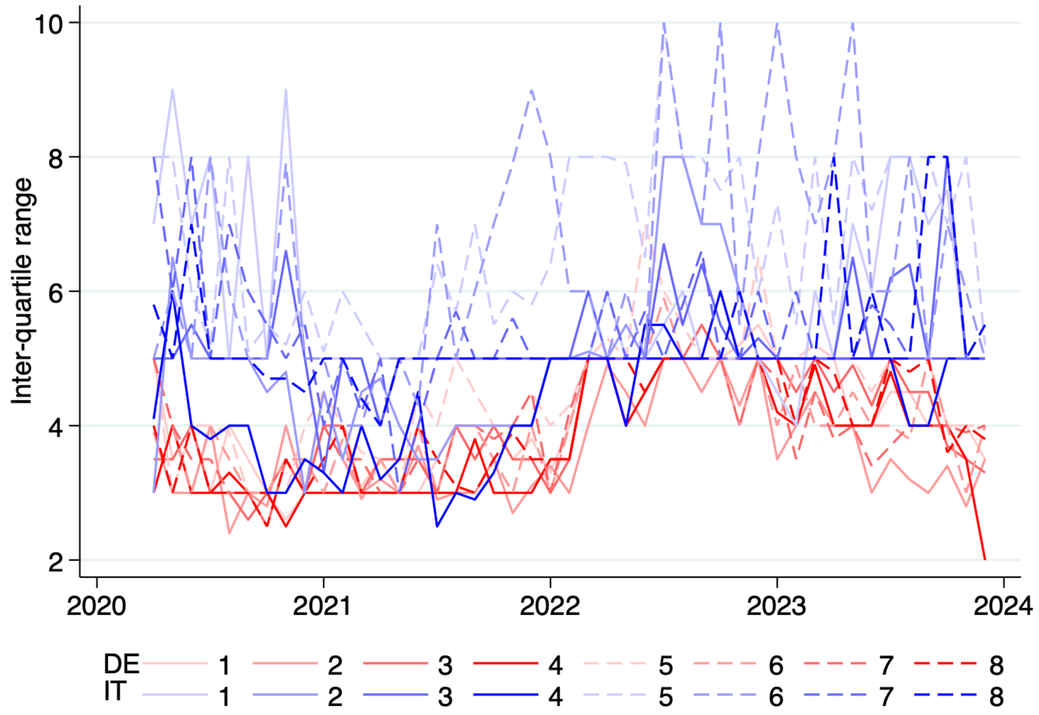
(a) Expected inflation: Germans and Italians



- Lots of variation
- Large country and group fixed effects
- Also lots of variation in actual inflation

Inflation expectations anchor

(b) Anchored expectations: Germans and Italians



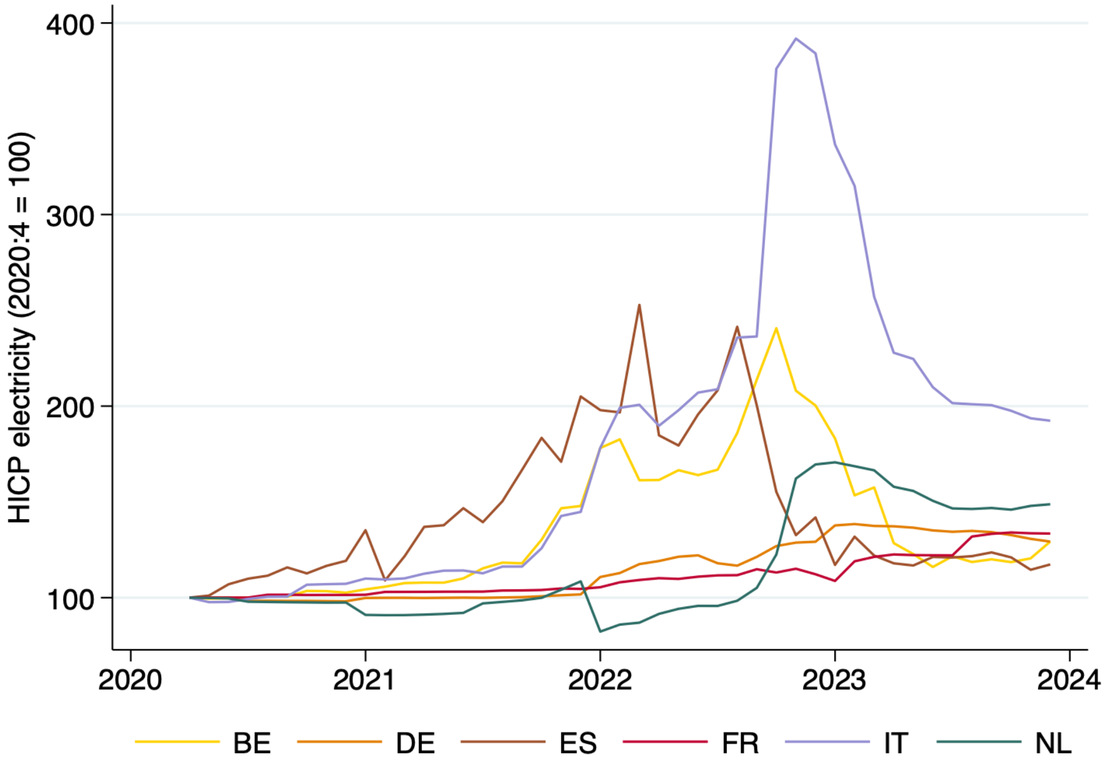
$a_{c,g,t}$ measure of how unanchored

- Higher-order moments of the distribution of long-term inflation expectations: 6-month change in the interquartile range of expected inflation 3-years ahead within country-group

- Difference between expected inflation and the inflation target: 6-month change in the absolute difference between expected inflation 3-years ahead and the ECB's inflation target averaged by country-group.

Electricity prices across countries and time

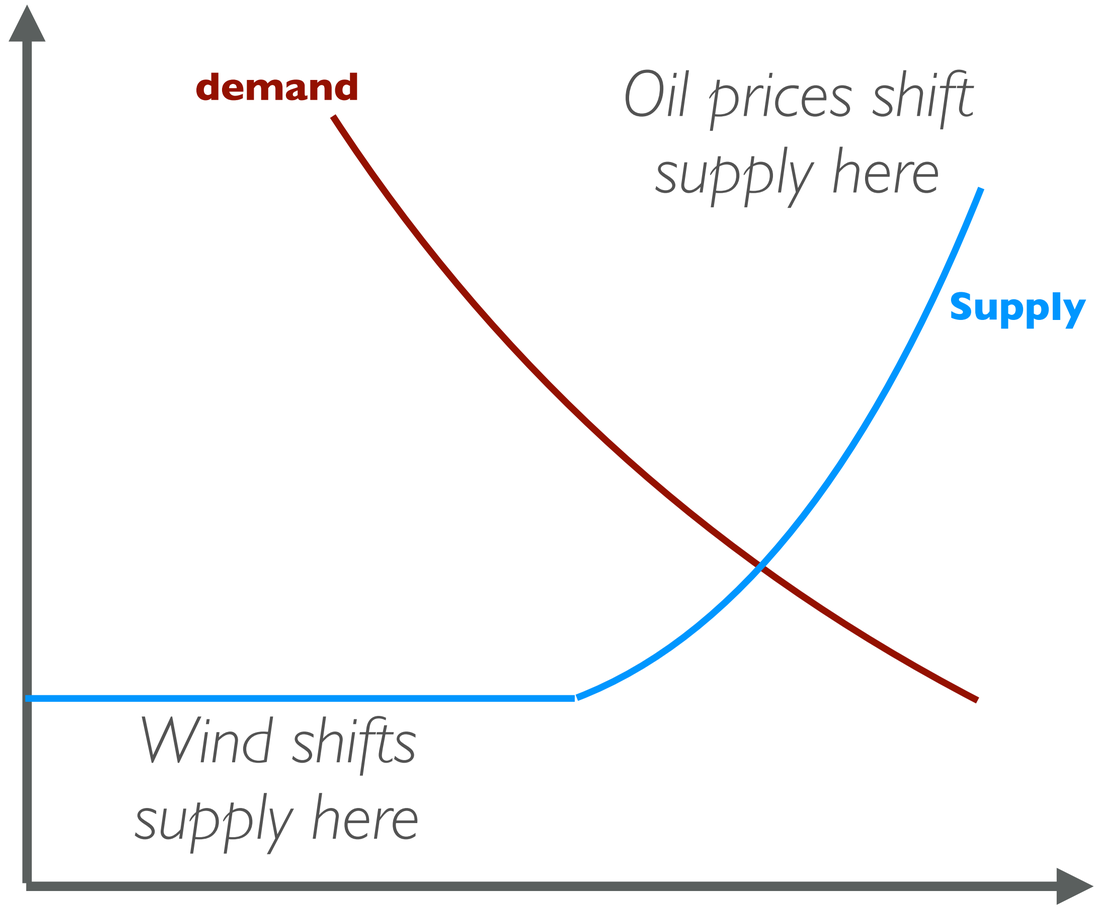
(c) Electricity prices across countries



$e_{c,t}$ log electricity prices per country

- 25% of energy consumption
- Segmented markets
- HICP electricity paid by households inclusive of taxes and subsidies
- Alternatives: energy, wholesale, city index

Supply shocks: shares, oil, wind



- $z_{c,t} = e_t s_c$: shift-share, cross-country differences in expenditure shares affect expected inflation, but do not affect aggregate prices.
- $z_{c,t} = k_t s_c$: both shift and share are now exogenous, as use high-frequency change in oil futures prices following OPEC production announcements,
- $z_{c,t} = w_{c,t}$: total energy generated through wind , exogenous to demand, mostly about wind speed

A flexible model of expectations

$$\pi^{e}_{i,c,g,t} = \underbrace{\omega e_{c,t}}_{\text{direct}} + \underbrace{x_{i,c,g,t}}_{\text{signal}} + \underbrace{\lambda^{\varepsilon}_{c,g}\varepsilon_{i,c,g,t}}_{\text{group effects}} + u_{i,c,g,t}$$

Attentive (λ) : $x_{i,c,g,t} = \phi e_t + \phi^{c}(e_{c,t} - e_t) + u^{x}_{i,c,g,t}$

Inattentive (λ) : $x_{i,c,g,t} = \phi^{a} e_{c,t} + u^{x}_{i,c,g,t}$

Noisy idyosincratic signals : $\lambda^{\varepsilon}_{c,g}\varepsilon_{i,c,g,t} \approx \lambda^{\varepsilon} e_{c,t} a_{c,g,t} + u^{\varepsilon}_{i,c,g,t}$

Empirical model of expectations

$$\sum_i \pi^e_{i,c,g,t} = [\omega + \lambda\phi^c + (1-\lambda)\phi^a](e_{c,t} - e_t)$$
$$+[\omega + \lambda\phi + (1-\lambda)\phi^a]e_t$$
$$+(1-\lambda)\lambda^\varepsilon e_{c,t}a_{c,g,t}$$
$$+\sum_i (u_{i,c,g,t} + u^x_{i,c,g,t} + u^\varepsilon_{i,c,g,t}) .$$

➡ Direct impact + RA impact + limited information

➡ Higher dispersion as anchoring from attention

➡ Not independent of energy, nor zero over time. Group and country fixed effects.

- Role of time fixed effects: absorb second term so coefficient on first term. Without them, would get coefficient on second term. Likely larger without.
- Without is arguably more adequate for macro questions, but do both

Specification

$$\Delta^6 \pi^e_{i,c,g,t} = \beta \Delta^6 e_{c,t} + \gamma \Delta^6 e_{c,t} \times \Delta^6 a_{c,g,t} + \alpha_c + \eta_g + \theta^\pi \bar{\pi}_{c,t-6} + \rho \Delta^6 r_t + error_{i,c,g,t}$$

- β: *by how much (basis points) does expected inflation over the next year increase on average when energy prices rise by 1%?*

- γ: *by how much more does the 1% rise in energy prices increase inflation expectations when those expectations are less well anchored?*

- $\Delta^6 \hat{\pi}^e_{i,c,g,t}$ and $\hat{\beta} \Delta^6 e_{c,t} + \hat{\gamma} \Delta^6 e_{c,t} \times \Delta^6 a_{c,g,t}$: *how much of the up and down of expected inflation in 2021-23 was due to energy shocks?*

Energy supply shocks

$$\Delta^6 \pi^e_{i,c,g,t} = \beta \Delta^6 z_{c,t} + \gamma \Delta^6 z_{c,t} \times \Delta^6 a_{c,g,t} + \alpha_c + \eta_g + \theta^\pi \bar{\pi}_{c,t-6} + \rho \Delta^6 r_t + error_{i,c,g,t}$$

- Going deeper into theory
  - as *h* rises β may at first rise due to attention even if shock dissipates
  - As *h* rises, γ should fall.

- Local projections:

$$\pi^e_{c,g,t+h} = \beta^h z_{c,t} + \gamma^h z_{c,t} A_{c,g,t} + \sum_{p=1}^{P} \tilde{\beta}^h_p z_{c,t-p} + \sum_{p=1}^{P} \tilde{\gamma}^h_p z_{c,t-p} A_{c,g,t}$$
$$+ \sum_{p=1}^{P} \psi^h_p \pi^e_{c,g,t-p} + \alpha^h_c + \eta^h_g + \theta^h \bar{\pi}_{c,t} + \rho^h r_t + \phi^h + \varepsilon_{c,g,t+h}$$

Table 1: The impact of electricity prices on expected inflation

Revision of expectation	(1)	(2)	(3)	(4)	(5)	(6)
Change in electricity prices	1.404***	1.167***	1.222***	1.531***	1.397***	0.372**
	(0.296)	(0.103)	(0.229)	(0.329)	(0.294)	(0.181)
Change in electricity prices	0.596***	0.199***	2.609***	1.499***	0.617***	0.146
× Unanchoring	(0.171)	(0.061)	(0.466)	(0.374)	(0.173)	(0.089)
Average past inflation	0.004	-0.025***	-0.001	0.009	0.005	0.004
	(0.028)	(0.009)	(0.025)	(0.027)	(0.028)	(0.079)
ECB deposit rate change	-0.436***	-0.449***	-0.442***	-0.438***	-0.437***	
	(0.119)	(0.031)	(0.113)	(0.118)	(0.119)	
Observations	362756	2472	362756	362756	362756	362756
R^2	0.016	0.343	0.018	0.016	0.016	0.032
Country & group fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	No	No	No	No	No	Yes
Country-group fixed effects	No	No	No	No	Yes	No

Note: This table presents estimates of the regression in equation (1): $\Delta^6 \pi^e_{i,c,g,t} = \beta \Delta^6 e_{c,t} + \gamma \Delta^6 e_{c,t} \times \Delta^6 a_{c,g,t} + \alpha_c + \eta_g + \theta \bar{\pi}_{c,t-6} + \psi \Delta^6 r_t + \varepsilon_{i,c,g,t}$. Column (1) has the baseline estimates, (2) uses the average $\pi^e_{c,g,t}$ as the dependent variable, (3) uses as measure of unanchoring the deviation of long-run expected inflation from target, (4) uses anchoring at the country level only $a_{c,t}$, (5) includes country-group fixed effects, and (6) includes time fixed effects. In parentheses are standard errors clustered by month for the regressions using individual expectations.

Robustness

(1) Alternative compositions of the panel: balanced with only 6 countries, weighting observations by number of respondents, using median expectation, different interactions of fixed effects

(2) Time variation: results by country

(3) Horizon: 1-12 months

(4) Other energy measures

(5) Controlling for squared energy prices, change in inflations

(6) Anchoring: by itself and more on distance from target

(7) Standard errors: two-way clustering, Driscoll-Kray, Huber-White

Table 2: The impact of energy prices on expected inflation in the US Fed SCE

	(1)	(2)	(3)	(4)	(5)	(6)
Change in energy prices	1.804**	1.942***	1.939**	0.300	1.690***	0.864***
	(0.740)	(0.721)	(0.743)	(1.049)	(0.301)	(0.220)
~~Change in energy prices × Unanchoring~~	-0.024	0.058	0.766	0.002	0.062	0.043
	(0.132)	(0.100)	(0.478)	(0.137)	(0.086)	(0.049)
Average past inflation	0.002	-0.094	0.005	-0.003	-0.064	-0.067
	(0.085)	(0.061)	(0.085)	(0.097)	(0.077)	(0.081)
Change in FFR	0.047	-0.058	0.033		-0.169	-0.160
	(0.397)	(0.408)	(0.401)		(0.343)	(0.421)
Observations	17903	7100	17903	17903	17907	17907
R^2	0.016	0.008	0.017	0.022	0.018	0.017
Country & group fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	No	No	No	Yes	No	No

Note: This table presents estimates of the regression in equation (3): $\Delta^6 \pi^e_{i,c,g,t} = \beta \Delta^6 e_{c,t} + \gamma \Delta^6 e_{c,t} \times \Delta^6 a_{c,g,t} + \alpha_c + \eta_g + \theta \bar{\pi}_{c,t-6} + \varepsilon_{i,c,g,t}$ for the US SCE. Columns 1–4 show estimates for state-level electricity prices. Column (1) has the baseline estimates, (2) uses the average $\pi^e_{c,g,t}$ as the dependent variable, (3) uses as measure of unanchoring the deviation of long-run expected inflation from target, and (4) includes time fixed effects. Columns (5) and (6) respectively use the national gas and oil price instead of regional electricity prices. Past inflation is computed using the state-level CPI from Hazell et al. (2022). We exclude all individuals part of state-demographic groups with less than 5 members in the month. In parentheses are standard errors clustered by month for the regressions using individual expectations.

Energy shocks

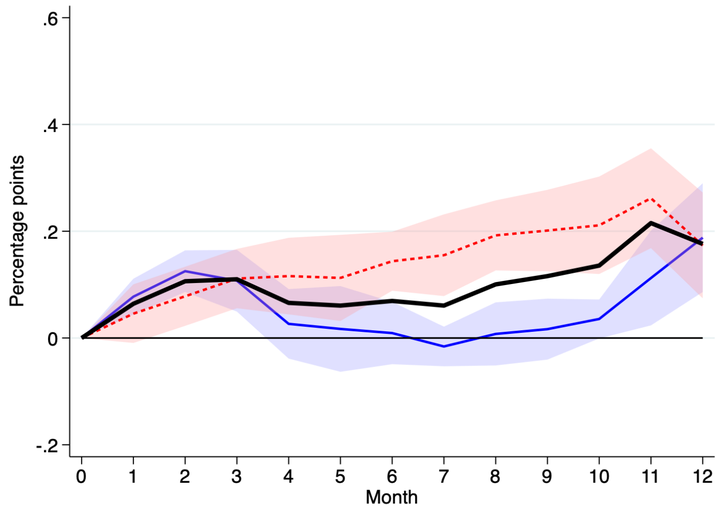
Table 3: The impact of energy shocks on expected inflation

Revision of expectation	(1)	(2)	(3)	(4)	(5)
Energy price shock	0.185***	0.613***	0.339***	0.044	0.603**
	(0.060)	(0.061)	(0.102)	(0.100)	(0.265)
Energy price shock × Unanchoring	0.244***	0.138***	-0.002	-0.042	0.146***
	(0.031)	(0.029)	(0.062)	(0.076)	(0.050)
Average past inflation	-0.025	0.081***	-0.079	-0.051*	0.213
	(0.025)	(0.021)	(0.086)	(0.027)	(0.144)
ECB deposit rate change	-0.352***	-0.423***	-0.103	-0.370**	-0.708**
	(0.117)	(0.061)	(0.228)	(0.142)	(0.267)
Observations	362756	362756	305037	362224	197950
R^2	0.018	0.027	0.015	0.012	0.029

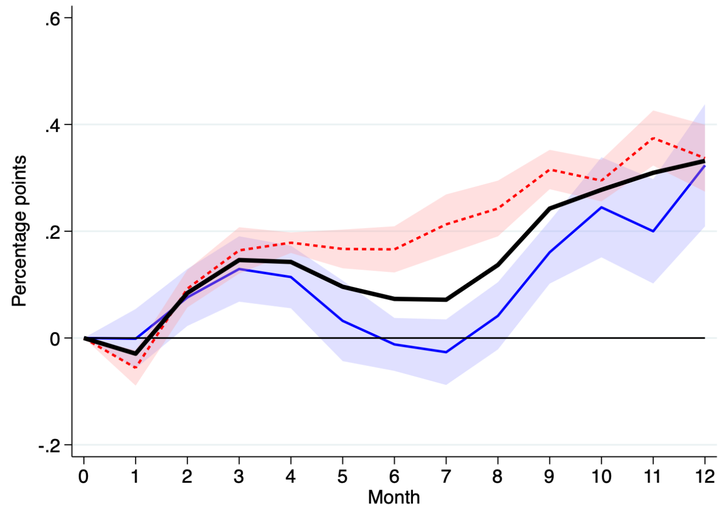
Note: This table presents estimates of the regression equation $\Delta^h \pi^e_{i,c,g,t} = \beta \Delta^h z_{c,t} + \gamma \Delta^h z_{c,t} \times \Delta^h a_{c,g,t} + \alpha_c + \eta_g + \theta \bar{\pi}_{c,t-6} + \rho \Delta^h r_t + \varepsilon_{i,c,g,t}$ where the first four columns use different measures of $z_{c,t}$. The energy shocks are, in order: (1) the h-month change in HICP electricity prices by country, (2) the h-month change in EA-wide HICP electricity times country-specific electricity expenditure weights in 2019, (3) OPEC supply shocks to oil prices cumulated over h months times country-specific expenditure weights in 2019, and (4) the h-month change in wind-source electricity generation, all standardised to increase electricity prices. The first four columns set $h = 6$, while the fifth column uses the oil shocks with $h = 12$. In parentheses are standard errors clustered by month.

Figure 2: Impulse response of expected inflation to a shock in energy prices

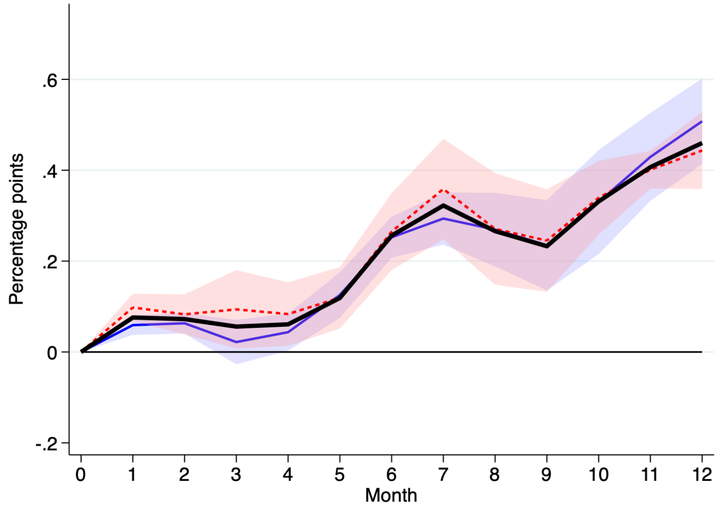
(a) Country electricity prices



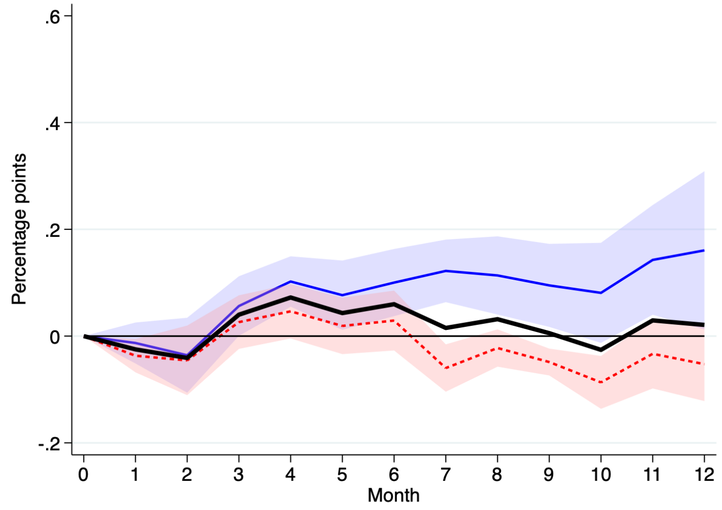
(b) EA electricity prices with country shares



(c) Oil shifts and energy shares



(d) Wind



Counterfactuals

Figure 3: The contribution of electricity prices to expectation revisions

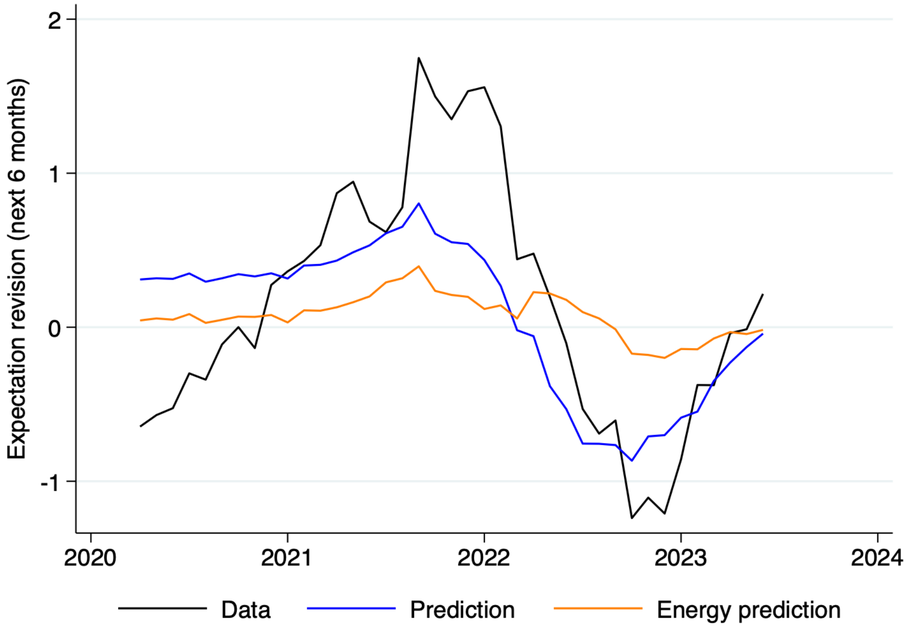
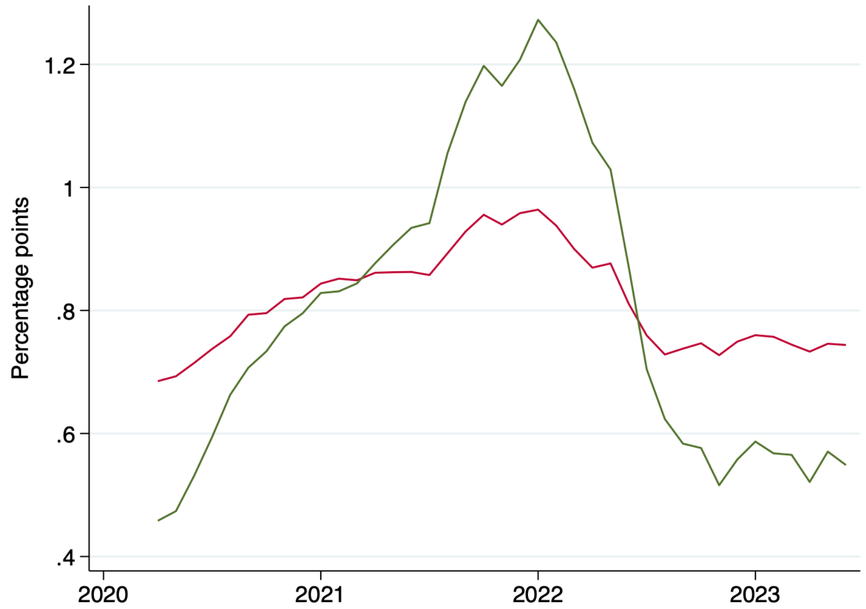


Figure 4: The time-varying impact of electricity prices on expected inflation



Conclusion

- **Does expected inflation over-react to energy prices?**
  - Yes, disproportionate attention of households to energy and it stands out among fundamentals.
  - Found they significantly matter with some credible identification.
  - But still under reaction.
  - Anchoring makes a difference
  - Energy shocks of 2021-23 were not behind rise in expected inflation