Heterogeneous information, subjective model beliefs, and the time-varying transmission of shocks

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Motivation

Expectations are formed using **information** *and* **subjective model**.

- e.g. full information , rational expectations

- Evidence for heterogeneity in both (Link et al, 2021, Macaulay and Moberly, 2022)

Question: How does heterogeneity in these features of expectations affect macroeconomic dynamics?

Motivation

Expectations are formed using **information** *and* **subjective model**.

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Question: How does heterogeneity in these features of expectations affect macroeconomic dynamics?

1. **Decomposition:** extra transmission channel: Cov(information, subjective models).
2. **Empirics:** document joint distribution of info & subjective models around inflation.
3. **Implications:** selective 'baking in' of expectations.

The Narrative Heterogeneity Channel

Earnings Heterogeneity: shock amplified if:

$$Cov(\text{MPC}, \text{shock exposure}) > 0$$

i.e. if the **shock** is concentrated among those who **react** the most to it (Auclert, 2019).

Narrative Heterogeneity:

$$Cov\left(\frac{\partial \mathbb{E}_t^h x_t}{\partial x_t}, \frac{d\mathbb{E}_t^h z_t}{d\mathbb{E}_t^h x_t}\right)$$

i.e. if **information** on the shock is concentrated among those who **update other expectations** the most to it.

Why narrative? sketch proof

Measuring information and subjective models

Unique questions in the Bank of England Inflation Attitudes Survey.

- Repeated cross-section, quarterly since 2001. $\approx$ 4000 households each Q1, $\approx$ 2000 in other quarters.

Subjective model only: "If prices started to rise faster than they are now, do you think Britain's economy would end up stronger, or weaker, or would it make little difference?"

Information only: "What were the most important factors in getting to your expectation for how prices in the shops would change over the next 12 months?"

- Define indicator $= 1$ if select a direct information source. Info sources detail

Demographic composition Relationship to planned consumption

Two key results

Fact 1: Models where inflation...

- is positive/negative: **same** information.
- makes no difference: **less** information.

detail

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Fact 2: More households believe inflation weakens the economy...

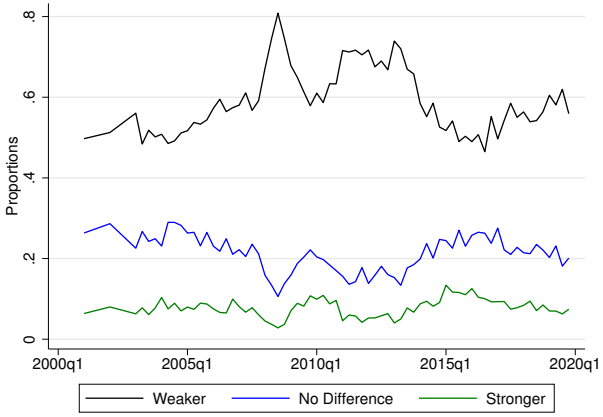
- when **realised inflation is high**.

detail

$$Corr(\Pr(\text{weaker}), \pi_t) = 0.78$$

Perceived inflation by model

Figure: Proportions with each response about how higher inflation would affect the strength of Britain's economy



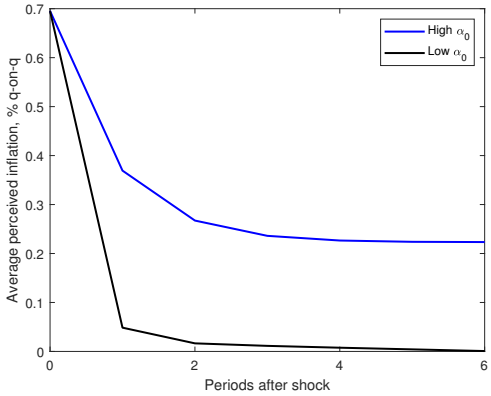
Model

Partial equilibrium, consumption-saving model. detail

Key ingredients:

1. Information about current inflation is **costly**.
   - Matches cross-section.
2. High perceived inflation $\Rightarrow$ **update** subjective model towards inflation eroding real income. Microfoundation
   - Matches time series.

Perceived inflation after an i.i.d. inflation shock



If start with **negative** model:

- $\pi_t \uparrow \implies$ subjective model gets even more negative.
- Pay more attention, quickly adjust $\mathbb{E}_t \pi_t$ down after shock.

If start with **positive** model:

- $\pi_t \uparrow \implies$ subjective model updates towards 'inflation doesn't matter'.
- Pay less attention, **do not** adjust $\mathbb{E}_t \pi_t$ beliefs down after shock.

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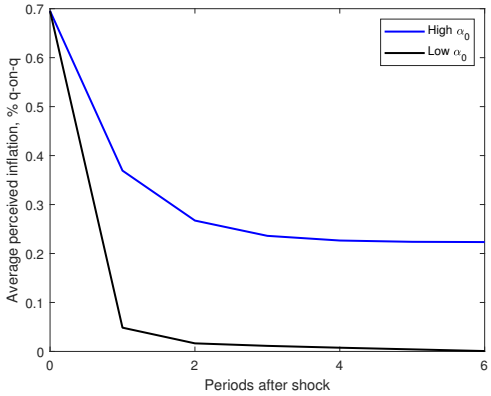

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- $\pi_t \uparrow \implies$ subjective model updates towards 'inflation doesn't matter'.
- Pay less attention, **do not** adjust $\mathbb{E}_t \pi_t$ beliefs down after shock.

$\implies$ **permanent** change in the narrative heterogeneity channel.

Why 'narrative heterogeneity'? Back

Gibbons & Prusak (2020 AEA P&P): a narrative is a pair (situation, action)

"Prices are currently rising (information), so my salary buys less, therefore I should spend less (how I should react)"

Appropriate action depends on **subjective model** - how you use information to update expectations.

Implication: Different info & models between households $\equiv$ different narratives.

The narrative heterogeneity channel: a general model

Back

Log-linear policy function: $\underbrace{\boldsymbol{x}_t^h}_{\text{choices}} = \underbrace{\boldsymbol{\mu}_t^h}_{\text{preferences}} \cdot \underbrace{\mathbb{E}_t^h \boldsymbol{z}_t^h}_{\text{expected external variables}}$

How does each expected variable respond to a shock?

$$\frac{d\mathbb{E}_t^h z_{it}^h}{dz_{nt}^h} = \underbrace{\frac{d\mathbb{E}_t^h z_{it}^h}{dz_{nt}^h}\Big|_{\mathbb{E}_t^h z_{j\neq i,t}}}_{\text{direct info } \delta_{int}^h} + \sum_{j\neq i}^{N_z} \underbrace{\frac{\partial \mathbb{E}_t^h z_{it}^h}{\partial \mathbb{E}_t^h z_{jt}^h}}_{\text{subj. model } \mathcal{M}_{ijt}^h} \cdot \frac{d\mathbb{E}_t^h z_{jt}^h}{dz_{nt}^h}$$

$$\implies \frac{d\mathbb{E}_t^h \boldsymbol{z}_t^h}{dz_{nt}^h} = \underbrace{(\boldsymbol{I} - \boldsymbol{\mathcal{M}}_t^h)^{-1}}_{\text{cross-learning } \chi_t^h} \boldsymbol{\delta}_{nt}^h$$

Response of **aggregate** choice variable x_{kt} to the shock:

$$\frac{d\bar{x}_{kt}}{dz_{nt}} = \sum_{i=1}^{N_z}\sum_{j=1}^{N_z}\left[\bar{\mu}_{ki,t}\bar{\chi}_{ij,t}\bar{\delta}_{jn,t} + Cov_H(\mu_{ki,t}^h, \chi_{ij,t}^h\delta_{jn,t}) + \underbrace{\bar{\mu}_{ki,t}Cov_H(\chi_{ij,t}^h, \delta_{jn,t}^h)}_{\text{narrative heterogeneity channel}}\right]$$

Measuring information

Back

What were the most important factors in getting to your expectation for how prices in the shops would change over the next 12 months?

Reports of current inflation in the media
Discussion of the prospects for inflation in the media

} **Direct information**

The level of interest rates
The inflation target set by the government
The current strength of the UK economy
Expectations about how economic conditions in the UK are likely to evolve
How prices have changed in the shops recently, over the last 12 months
How prices have changed in the shops, on average, over the longer term
i.e the last few years
Other factors
None

} **Cross-learning**

Define indicator $= 1$ if select a direct information source.

Other measures

Demographic variation in model beliefs and information

Back

	Stronger	No Difference	Weaker	No information	Information
Age	46.28	49.18***	45.97**	47.65	47.09
Higher Education	0.28	0.24***	0.27**	0.30	0.33***
Income $> 25k$	0.40	0.37***	0.41***	0.43	0.43
Female	0.45	0.49***	0.53***	0.51	0.52
MP Knowledge	0.70	0.69	0.70	0.74	0.74

Stars denote significance of difference to 'stronger' group or 'No information' group. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. 'MP Knowledge' is a dummy variable $= 1$ if the respondent correctly identifies the Bank of England as the body responsible for setting base interest rates.

Multinomial logit of model beliefs on age, gender, class, employment status, income, education, region, homeownership, time FEs: pseudo-$R^2 = 0.035$ (models), $= 0.012$ (information)

Relationship of information indicator to other measures of direct information

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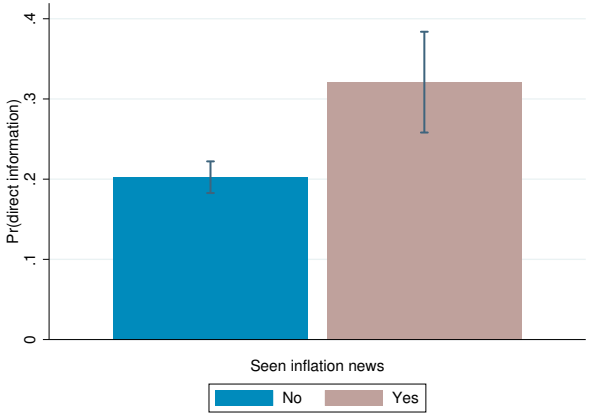
Question: The latest CPI inflation figure was released on 12th February. Have you seen any reports, for example in the media, showing the latest inflation figure? (2013 Q1 only)[1]



[1] Bars show weighted means of the information indicator. Lines show 90% confidence intervals.

Consumption plans, subjective models and information

Back

Q: Which, if any, of the following actions are you taking, or planning to take, in the light of your expectations of price changes over the next twelve months?
b) cut back spending and save more.

Define *c* response indicator =1 if answer 'no'.

Table: probit regression of indicator on subj. models interacted with information, omitted category is 'weaker' & no direct info.

	c response to Eπ
information	-0.213***
indicator=1	(0.0611)
end up stronger	0.0108
	(0.0891)
information	0.348*
indicator=1 $\times$ end up stronger	(0.185)
make little	0.130**
difference	(0.0594)
information	0.0240
indicator=1 $\times$ little difference	(0.126)
HH controls	Yes
Time FE	Yes
Observations	4940

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Fact 1: information and models in the cross-section[2]

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	Info indicator
End up stronger	-0.00827
	(0.0192)
Make little difference	-0.0315**
	(0.0129)
Don't know	-0.0605***
	(0.0172)
HH controls	Yes
Time FE	Yes
Observations	8270

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Fact 1: models where inflation...

- is positive vs. negative: **same** information.
- makes no difference: **less** information.

[2]Table shows average marginal effects from probit regression of info indicator on models. Omitted category: inflation makes the economy weaker.

Fact 2: models in the time series

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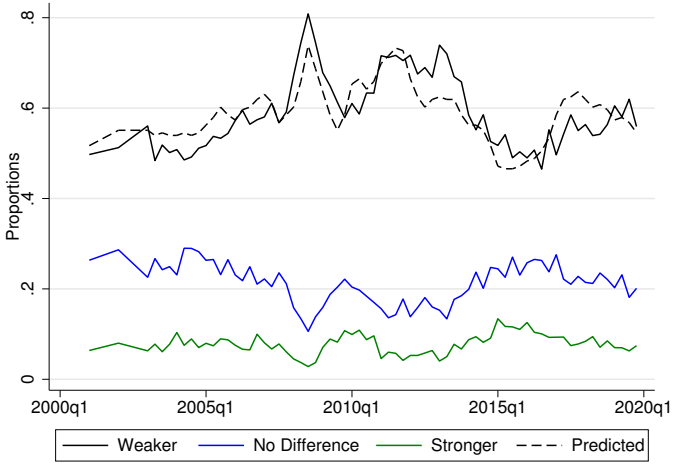
Figure: Proportions with each response about how higher inflation would affect the strength of Britain's economy



Modal answer: inflation makes the economy weaker.

$$\implies Cov(\text{info}, \frac{d\mathbb{E}^h y}{d\mathbb{E}^h \pi}) < 0$$

Dashed line: $\Pr(\hat{\text{weaker}}) = 0.057 \times \text{CPI inflation}_t + 0.466$

Fact 2: More households believe inflation weakens the economy when **realised inflation is high**.

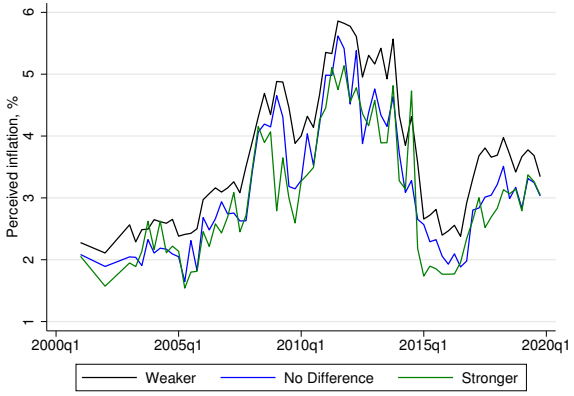
$$Corr(\Pr(\text{weaker}), \pi_t) = 0.78$$

Perceptions by subjective model

Back

If inflation $\Longrightarrow$ models: Within a period, households with **higher** perceived inflation are **more negative** about the effects of inflation.

Figure: Inflation perception over past 12 months by subjective model



After household controls and time FEs, $\mathbb{E}_t^h \pi_t$ of a household with a **negative** model of inflation is:

- 54 b.p. $>$ those with neutral model
- 70 b.p. $>$ those with positive model

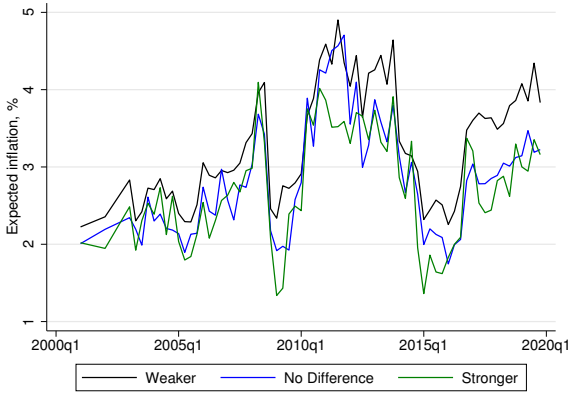
Equivalent for expectations

Expectations by subjective model

Back

Within a period, households with **higher** expected inflation are **more negative** about the effects of inflation.

Figure: Inflation expectation over next 12 months by subjective model



After household controls and time FEs, $\mathbb{E}_t^h \pi_{t+1}$ of a household with a **negative** model of inflation is:

- 47 b.p. $>$ those with neutral model
- 57 b.p. $>$ those with positive model

A simple consumption-saving model: setup

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Setup:

$$\max_{C_t} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} \quad \text{s.t.} \quad P_t C_t + B_t = R_{t-1} B_{t-1} + P_t W_t$$

Log-quadratic approximation to objective function.

Subjective models:

$$\pi_t = \rho_\pi^h \pi_{t-1} + u_{\pi t}$$

$$r_t = \phi^h \pi_t + u_{it}$$

$$w_t = \alpha^h \pi_t + \lambda^h r_t + \rho_w^h w_{t-1} + u_{wt}$$

Key ingredients:

1. Information about current inflation is **costly**.
2. **Update** α^h with perceived inflation: $\hat{\alpha}_t^h = \alpha_0^h + \alpha_1^h \mathbb{E}_t^h \pi_t$.

Microfoundation

Microfounding endogenous α^h Back

Indirect utility:

$$\tilde{\mathbb{E}}_0^h \hat{U}_0^h = \frac{1-\beta}{(1-\beta\rho_w^h)^2} w_0 - \sigma\beta r_0 + \frac{1}{1-\beta\rho_\pi^h}\left(\frac{\beta\rho_\pi^h(\alpha^h+\lambda^h\phi^h)}{1-\beta\rho_w^h} - \sigma\beta^2\phi^h\rho_\pi^h + \frac{\partial c_t^h}{\partial \tilde{\mathbb{E}}_t^h \pi_t}\right)\tilde{\mathbb{E}}_0^h\pi_0 - \frac{\log(\bar{C}^h)}{2(1-\beta)}\left(\frac{\partial c_t^h}{\partial \tilde{\mathbb{E}}_t^h \pi_t}\right)^2 \frac{(1-K^h)\sigma_\pi^2}{1-(\rho_\pi^h)^2(1-K^h)}$$

Increasing in α^h iff:

$$\tilde{\mathbb{E}}_0^h\pi_0 > \frac{\log(\bar{C}^h)(1-K^h)\sigma_\pi^2}{(2-\beta)(1-(\rho_\pi^h)^2(1-K^h))} \cdot \frac{\partial c_t^h}{\partial \tilde{\mathbb{E}}_t^h \pi_t}$$

Therefore if household faces Knightian uncertainty about α^h, distort to worst case after forming $\tilde{\mathbb{E}}_0^h\pi_0$. High perceived $\pi \implies$ worst case is low α.