Shock Transmission and the Sources of Heterogeneous Expectations

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Motivation

- Expectations are heterogeneous (Mankiw et al, 2004; Dovern et al, 2012; etc. etc...).
- Policymakers (usually) focus on average expectations, ignore the dispersion.
- Is this a problem?

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- Is this a problem?

Question: When and how does the heterogeneity affect macro shock transmission, **beyond effects summarized by the average**?

Key step: What is the source of the heterogeneity?

The Sources of Heterogeneity

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$\Longrightarrow$ Heterogeneity could come from

1. **Information** - relax full information (e.g. Link et al, 2021).

2. **Subjective models** - relax rational expectations (e.g. Andre et al, 2022).

3. **Both** - (e.g. Macaulay & Moberly, 2022).

Answer: Expectations heterogeneity affects macro shock transmission when **information** is correlated with **subjective models** across agents.

Three Contributions

General

1. **Decomposition:** novel transmission channel in general GE model:
   Cov(information, subjective models).

Specific Application

2. **Empirics:** document joint distribution of info & subjective models around inflation.

3. **Implications:** time-varying shock transmission, selective 'baking in' of expectations.

Example: Announcing a Mini-Budget

Two groups of investors:

	A	B
Subjective model: perceived effect on ΔGDP?	$\uparrow$	$\downarrow$
Reaction if observe tax cuts	**buy** £	**sell** £

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	A	B
Subjective model: perceived effect on ΔGDP?	$\uparrow$	$\downarrow$
Reaction if observe tax cuts	**buy** £	**sell** £

Information: If **both** observe the mini-budget: $\Delta AD(£) = \uparrow + \downarrow$

Alternatives:

- **A** observe, **B** don't: $\Delta AD(£) = \uparrow$
- **A** don't observe, **B** do: $\Delta AD(£) = \downarrow$

Aggregate effects depend on the relationship between information and subjective models.

Novel Channel: Absent in Existing Models

	Full info	**Relax full info**
Full model knowledge	Standard macro model (no heterogeneity)	Rational Inattention, Sticky Information etc
Relax model knowledge	Learning, Robustness, Imperfect Common Knowledge etc	**This paper**

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Interaction of heterogeneous information and subjective models

$\Longrightarrow$ **Narrative Heterogeneity Channel**.

Why narrative?

Related Literature

Information frictions:

- Sims (2003), Reis (2006), Maćkowiak & Wiederholt (2009,2015), Auclert et al. (2020), Angeletos & Sastry (2021), Ellison & Macaulay (2021), Macaulay (2021)

Subjective/incorrect models:

- Brock & Hommes (1997), Branch & Evans (2006), Malmendier & Nagel (2016), Farhi & Werning (2020), Michelacci & Paciello (2020), Macaulay & Song (2022)

- Bordalo et al. (2018,2020), Angeletos et al. (2020), Bianchi et al. (2021), Maxted (2022), Kohlhas & Robertson (2022)

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Evidence of heterogeneity:

- Pfajfar & Santoro (2010), Candia et al. (2020), Coibion et al. (2020), Link et al. (2021), Dräger & Nghiem (2021), Goldstein & Gorodnichenko (2022)

- Patton & Timmermann (2010), Dräger et al. (2016, 2022), Laudenbach et al. (2021), Andre et al. (2022), Link et al. (2022), Macaulay & Moberly (2022)

The Narrative Heterogeneity Channel: General Intuition

Earnings Heterogeneity (Auclert, 2019):

$$\text{Income} \xrightarrow[\text{MPC}]{} \text{Consumption}$$

- Shock amplified if the **shock** is concentrated among those who **react** the most to it.
- i.e. if $Cov(\text{MPC}, \text{shock exposure}) > 0$

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Narrative Heterogeneity:

$$\text{Information} \xrightarrow[\text{Model}]{} \text{Expectations} \longrightarrow \text{Action}$$

- Shock amplified if **information** on the shock is concentrated among those who **update other expectations** the most in response to it.

The Narrative Heterogeneity Channel: General Case

Channel appears if **information** on a shock is correlated with the **subjective models** used to interpret it.

Paper: decompose effects of an arbitrary shock on an aggregate variable in any linear GE model into standard terms, **+**

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

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Existing models: only permit heterogeneity in <u>one</u> of the two components.

But	different models	$\Longrightarrow$	different incentives to acquire information.
+	different information	$\Longrightarrow$	different subjective models.

<u>Expect</u> systematic info-model relationships.

What Data Do We Need?

Problem: data on **expectations** conflates information and models.

Solution: 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.
- Measure information and models separately, so we can study their covariance.

Inflation Attitudes Survey: Unique Questions

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?

- Informative about $\frac{d\mathbb{E}^h y}{d\mathbb{E}^h \pi}$. Detail

Inflation Attitudes Survey: Unique Questions

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?

- Informative about $\frac{d\mathbb{E}^h y}{d\mathbb{E}^h \pi}$. Detail

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. Detail
- Informative about whether $\frac{\partial \mathbb{E}^h \pi}{\partial \pi} > 0$.

Demographic composition Relationship to planned consumption

Result 1: Information and Models in the Cross-Section[1]

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

Result 1: models where inflation...

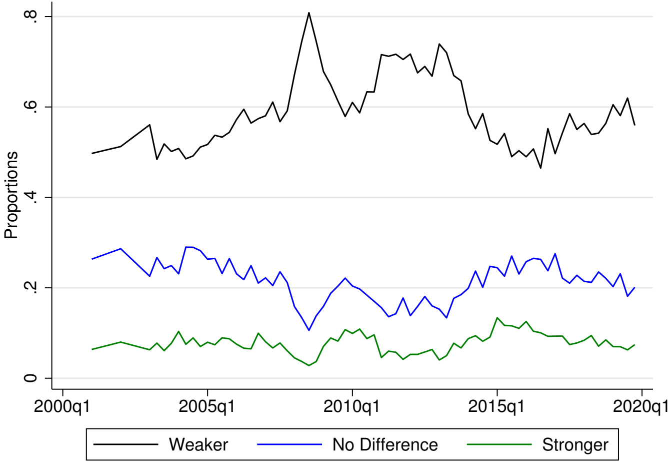
- is positive vs. negative: **same** information.
- makes no difference: **less** information.

Regression details

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

Result 2: Models in the Time-Series

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



Modal answer: inflation makes the economy weaker.

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

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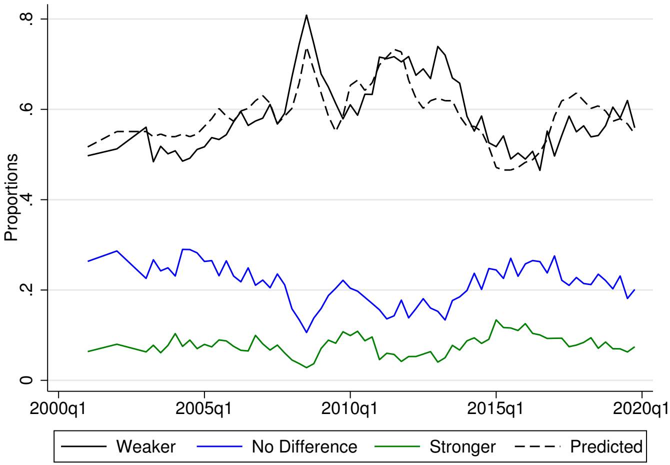

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$$\implies Cov\left(\text{info}, \frac{d\mathbb{E}^h y}{d\mathbb{E}^h \pi}\right) < 0$$

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

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

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

Heterogeneous Inflation Experiences GDP Growth

Model: The Household Problem

$$\max_{C_t^h} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \cdot \frac{(C_t^h)^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}$$

subject to

$$C_t^h + B_t^h = \frac{R_{t-1}}{\Pi_t} B_{t-1}^h + Y_t$$

Log-quadratic approximation to objective function (lower case = log-deviation from steady state).

Then household optimization $\implies$

$$c_t^h = (1-\beta) \sum_{s=0}^{\infty} \beta^s \mathbb{E}_t^h y_{t+s} - \beta\sigma \sum_{s=0}^{\infty} \beta^s (\mathbb{E}_t^h r_{t+s} - \mathbb{E}_t^h \pi_{t+s+1})$$

Supply-side Detail

Information

Observed:

- y_t, r_t
- + a noisy signal $s_t^h = \pi_t + \varepsilon_t^h$, where $\varepsilon_t^h \sim N(0, \sigma_{\varepsilon h}^2)$

Typical Approach (Full Information): $\sigma_{\varepsilon h}^2 = 0$

Here: $\sigma_{\varepsilon h}^2 > 0$, and is heterogeneous across households.

Subjective Models

Perceived Laws of Motion:

$$\pi_t = \rho_\pi^h \pi_{t-1} + u_{\pi t}$$
$$r_t = \phi^h \pi_t + u_{rt}$$
$$y_t = \alpha^h \pi_t + \lambda^h r_t + \rho_y^h y_{t-1} + u_{yt}$$

Typical Approach (Rational Expectations)**:** get these from true equilibrium laws of motion.

Here: (approx.) right functional form, but <u>heterogeneous parameters</u>

$\implies$ not Rational Expectations.

Fitting Survey Results

Make reduced-form assumptions on information and subjective models across households to fit the empirical correlations.

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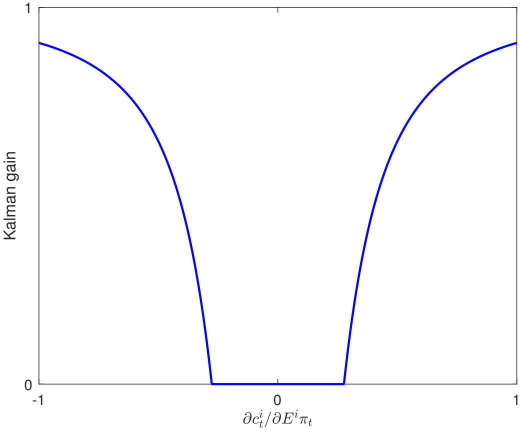
1. Larger $\left(\frac{dc_t^h}{d\mathbb{E}_t^h \pi_t}\right)^2$

$\implies$ more precise signals.

Figure: Information by subjective model



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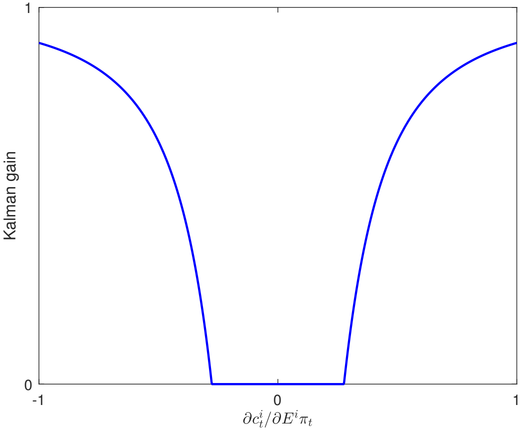
Microfoundation: information about π_t is costly (rational inattention).

- Intuition: information is more valuable if you believe it affects your choices.

Detail

Figure: Information by subjective model



Fitting Survey Results 2

2. Update α^i with perceived inflation:

$$y_t = \hat{\alpha}_t^h \pi_t + \lambda^h r_t + \rho_y^h y_{t-1} + u_{yt}$$

where

$$\mathbb{E}_t^h \pi_t \uparrow \implies \hat{\alpha}_t^h \downarrow$$

Result: $\pi_t \uparrow \implies \mathbb{E}_t^h \pi_t \uparrow$ for those with info$> 0 \implies \dfrac{\partial c_t^h}{\partial \mathbb{E}_t^h \pi_t} \downarrow$

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Microfoundation: ambiguity over α. Distort subjective model towards the worst case.

- Intuition: when inflation is high, the worst possible DGP is that inflation erodes y_t.

Models and Perceptions in the Cross-Section | Microfoundation Detail

Model Timing

Observe information → Form π_t perception → Update α^h → Form $\mathbb{E}_t^h \pi_{t+s}$, $\mathbb{E}_t^h y_{t+s}$, choose c_t → period $t+1$

For now: assume ‘central model’ constant over time. Update$_t$ is forgotten by $t+1$.

Extension: long-run expectations affect signal precision.

Implications

Calibrate the model to the survey data. The **narrative heterogeneity channel**: Detail

- Lowers $\frac{\partial \bar{c}_t}{\partial \pi_t}$ at steady state by **56%**.
- Increases time-series volatility (standard deviation) of $\frac{\partial \bar{c}_t}{\partial \pi_t}$ by **65%**.

Specific Implications:

- Baking in of high $\mathbb{E}\pi$. $\Rightarrow$
- Selection into information. $\Rightarrow$
- Survey RCTs & Central Bank communication. $\Rightarrow$
- Size & history-dependent shock transmission. $\Rightarrow$

Conclusion and Wider Agenda

Existing literature: heterogeneous $\mathbb{E}$s have little effect on aggregates.

Narrative heterogeneity channel: heterogeneous $\mathbb{E}$s are a channel of shock transmission.

This paper: Characterize the narrative heterogeneity channel in general, + application to beliefs around inflation.

Going forward: Other expectations (Macaulay & Moberly, 2022)? Determinants of heterogeneity (Macaulay & Song, 2022)? Firms? Asset pricing? Policy?

Why 'Narrative Heterogeneity'? Back

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

$$\text{“}\underbrace{\text{Prices are currently rising}}_{\text{information}}\text{, so my salary buys less, }\underbrace{\text{therefore I should spend less}}_{\text{how I should react}}\text{”}$$

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

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

Relationship to Shiller (2017) etc.

Relationship to Narrative Economics Literature Back

Shiller (2017 AER):

> *"We have to consider the possibility that sometimes the dominant reason why a recession is severe is related to the* ***prevalence and vividness of certain stories****, not the purely economic feedback or multipliers that economists love to model."*

This paper: the **distribution** of narratives also matters.

- Shiller (and subsequent lit.): which narratives spread, and how.
- This paper: how narratives affect macro *given* spread.

Eliaz and Spiegler (2020 AER):

- Narrative is a *causal chain* represented by a DAG.
- DAG is a subjective model, with restriction that it must be **recursive**.

The Narrative Heterogeneity Channel: a General Model Back

Log-linear policy function: $\underbrace{x_t^h}_{\text{action}} = \sum_{i=1}^{N} \underbrace{\mu_i^h}_{\text{coefficients}} \cdot \underbrace{\mathbb{E}_t^h z_{it}^h}_{\text{expected external variables}}$

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Response to an arbitrary shock ζ_t?

$$\frac{dx_t^h}{d\zeta_t} = \sum_{i=1}^{N} \mu_i^h \cdot \frac{d\mathbb{E}_t^h z_{it}^h}{d\zeta_t}$$

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Response to an arbitrary shock ζ_t? Sketch proof

$$\frac{dx_t^h}{d\zeta_t} = \sum_{i=1}^{N} \mu_i^h \cdot \frac{d\mathbb{E}_t^h z_{it}^h}{d\zeta_t} = \sum_{i=1}^{N} \mu_i^h \cdot \sum_{j=1}^{N} \chi_{ij,t}^h \delta_{j,t}^h$$

where:

- $\delta_{j,t}^h = \left.\frac{d\mathbb{E}_t^h z_{jt}^h}{d\zeta_t}\right|_{\mathbb{E}_t^h z_{k\neq j,t}}$: **direct info** about z_{jt}^h.

- $\chi_{ij,t}^h = \frac{d\mathbb{E}_t^h z_{it}^h}{d\mathbb{E}_t^h z_{jt}^h}$: **cross-learning** from $\mathbb{E}_t^h z_{jt}^h$ to $\mathbb{E}_t^h z_{it}^h$.

The Narrative Heterogeneity Channel vs Other Channels Back

Response of **aggregate** choice variable $\bar{x}_t$ to the shock:

$$\frac{d\bar{x}_t}{d\zeta_t} = \sum_{i=1}^{N}\sum_{j=1}^{N}\left[\underbrace{\bar{\mu}_i \bar{\chi}_{ij,t}\bar{\delta}_{j,t}}_{\text{representative agent}} + \underbrace{Cov_H(\mu_i^h, \chi_{ij,t}^h \delta_{j,t}^h)}_{\text{response heterogeneity}} + \underbrace{\bar{\mu}_i Cov_H(\chi_{ij,t}^h, \delta_{j,t}^h)}_{\textbf{narrative heterogeneity}} \right]$$

Representative agent: if calibrate RA model to average preferences, subjective models, information.

Response heterogeneity: if shock exposure is correlated with choice function coefficients (e.g. MPCs in Auclert, 2019).

Narrative heterogeneity: if information is correlated with subjective models.

General Equilibrium

The Narrative Heterogeneity Channel: a General Model Back

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

How does each expected variable respond to a shock? Example

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

$$\Longrightarrow \frac{d\mathbb{E}_t^h \boldsymbol{z}_t^h}{d\zeta_t} = \underbrace{\left(\boldsymbol{I} - \boldsymbol{\mathcal{M}}_t^h\right)^{-1}}_{\text{cross-learning } \chi_t^h} \delta_t^h$$

General Equilibrium Back

Assumption 1: All elements of $\boldsymbol{z}_t^h$ are equal across agents h, and are such that:

$$A\boldsymbol{z}_t + B\bar{\boldsymbol{x}}_t + C\zeta_t = 0$$

Assumption 2: Agent information is such that:

$$\delta_t^h = \tilde{\delta}_t^h \frac{d\boldsymbol{z}_t}{d\zeta_t}$$

Result: General Equilibrium response of aggregate choice vector $\bar{\boldsymbol{x}}_t$ to the shock:

$$\frac{d\bar{\boldsymbol{x}}_t}{d\zeta_t} = -\mathbb{E}_H\left(\mu_t^h \chi_t^h \tilde{\delta}_t^h\right)\left(A + B\mathbb{E}_H\left(\mu_t^h \chi_t^h \tilde{\delta}_t^h\right)\right)^{-1} C e_\zeta$$

where e_ζ is a $N_\zeta \times 1$ vector with zero in every element, except for 1 in the element corresponding to the shocked element of ζ_t.

Measuring Subjective Models

Back

Question: 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?

How to interpret?

- Source of the shock? (Kamdar, 2019)
- Causal effects of inflation? (Andre et al, 2022)

Answer: it doesn't matter. All we need in the decomposition is $\frac{d\mathbb{E}^h y_{t+s}}{d\mathbb{E}^h \pi_t}$.

Responses indicate sign of cross-learning.

Demographic composition

Measuring Information Back

Information Sources:

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)

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

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

Result 1: Information and Models in the Cross-Section[2] Back

Regression:

$$\Pr(\text{info}_{it} = 1) = \Pr(I^*_{it} > 0)$$

$$I^*_{it} = \sum_{m=1}^{4} \mathbb{1}(\text{model}_{it} = m) + X_{it} + \gamma_t + \varepsilon_{it}$$

Controls:

- X_{it}: gender, age, class, employment status, income, education, region, home-ownership status.
- γ_t: quarter FEs.

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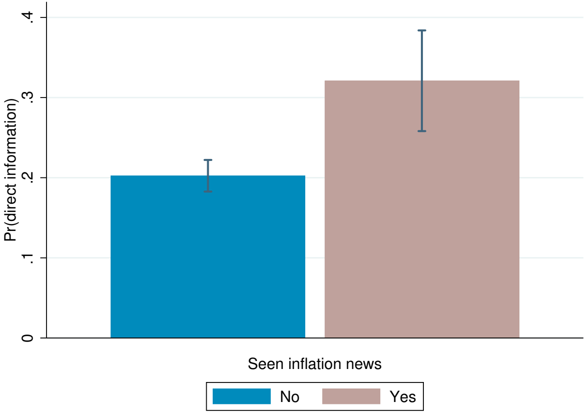
[2] Table shows average marginal effects from probit regression of info indicator on models. Omitted category: inflation makes the economy weaker.

Relationship of Information Indicator to Other Measures of Direct Information Back

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)[3]



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

Heterogeneous Inflation Experiences

Back

CPI is an average measure of inflation: hides inflation inequality (e.g. Xaravel, 2021).

ONS publishes inflation rates by retirement status, income decile, home ownership.

Correlations of various inflation measures with $\mathbb{1}(\textit{weaker})$:

	CPI	By retirement	By income	By housing	Own perception
$\mathbb{1}(\textit{weaker})$	0.130^{***}	0.114^{***}	0.120^{***}	0.092^{***}	0.150^{***}

Correlations with GDP Back

Table: Regressions of the proportion of households answering weaker to Question 1 on aggregate variables.

	(1) Proportion weaker	(2) Proportion weaker	(3) Proportion weaker
Inflation	0.0568***	0.0517***	0.0501***
	(0.00489)	(0.00479)	(0.00469)
GDP growth		-0.0261***	-0.0110
		(0.00869)	(0.0180)
Constant	0.466***	0.487***	0.482***
	(0.0109)	(0.0123)	(0.0152)
Omitted quarters	None	None	2008Q2-2009Q1
R-squared	0.615	0.647	0.554
Observations	70	70	66

Standard errors in parentheses

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

Model: firms and policy Back

Firms:

- Standard NK: monopolistic intermediate goods producers with sticky prices sell to perfectly competitive final goods aggregator. All firms have full information + rational expectations.

- Intermediate goods produced with labor only, supplied by monopolistic labor unions.

- Non-standard: labor unions have sticky real wages. Take stickiness $\to \infty$, so w_t^r fixed, only variation in real mc_t is from exogenous TFP.

$$\pi_t = \rho_\pi \pi_{t-1} + v_{\pi t}$$

- Household income composed of profits from firms and labor unions.

Policy:

- Taylor Rule: $r_t = \phi \pi_t + v_{rt}$

Subjective Models: Survey vs. Model Back

Question: 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?

1. Source of the shock? (Kamdar, 2019)

2. Causal effects of inflation? (Andre et al, 2022)

Raw Empirics: it doesn't matter. All we need in the decomposition is $\frac{d\mathbb{E}^h y_{t+s}}{d\mathbb{E}^h \pi_t}$.

Model: $\pi_t = \rho_\pi^h \pi_{t-1} + u_{\pi t}$. No role for demand shocks (i.e. assume interpretation 2).

- Tractability!

- In data, relationship between (π_t, models) is very consistent over 20 years: including demand-driven inflation (pre-2008) *and* supply driven (2016, 2021-2).

Microfounding the Information Distribution Back

Information about current inflation is **costly**.

$$\max_{C_t, s_t} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(C_t) - \psi(\{s_t\}^t)$$

where $\psi(\{s_t\}^t) \uparrow$ for more informative signals.

Results:

- Optimal signal is $s_t^h = \pi_t + \varepsilon_t^h$, with $\varepsilon_t^h \sim N(0, \sigma_{\varepsilon h}^2)$
- with $\sigma_{\varepsilon h}^2$ decreasing in $\left(\frac{dc_t^h}{d\mathbb{E}_t^h \pi_t}\right)^2$

Microfounding Endogenous α^i Back

Indirect utility:

$$\tilde{\mathbb{E}}_0^h \hat{U}_0^h = \frac{1-\beta}{(1-\beta\rho_y^h)^2} y_0 - \sigma\beta r_0 + \frac{1}{1-\beta\rho_\pi^h}\left(\frac{\beta\rho_\pi^h(\alpha^h+\lambda^h\phi^h)}{1-\beta\rho_y^h} - \sigma\beta^2\phi^h\rho_\pi^h + \frac{\partial c_t^h}{\partial\tilde{\mathbb{E}}_t^h\pi_t}\right)\tilde{\mathbb{E}}_0^h\pi_0$$
$$- \frac{\log(\bar{C}^h)}{2(1-\beta)}\left(\frac{\partial c_t^h}{\partial\tilde{\mathbb{E}}_t^h\pi_t}\right)^2 \frac{(1-K^h)\sigma_\pi^2}{1-(\rho_\pi^h)^2(1-K^h)}$$

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.

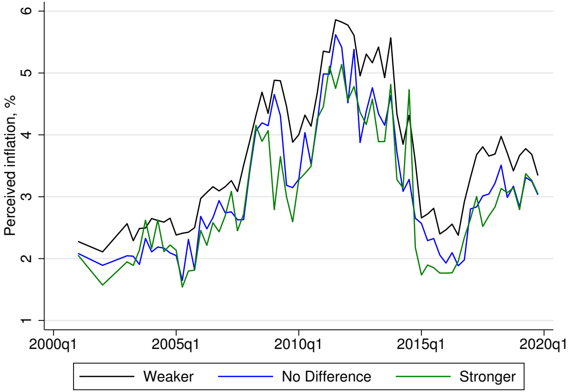
Direction of Causation? Back

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

Direction of Causation? Back

If inflation $\implies$ 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

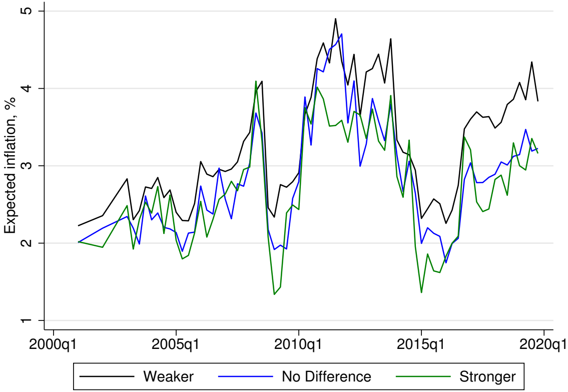
Equivalent for expectations

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

Quantifying the Narrative Heterogeneity Channel for Inflation Back

Calibrate model to UK: quarterly frequency. Normalise $\bar{C} = 1$.

Parameter	Value	Source	Parameter	Value	Source
β	0.99	standard	ρ_π	0.329	estimated subj. model
σ	1	standard	ρ_w	0.731	estimated subj. model
ϕ	β^{-1}	Lee et al (2013)	σ_π	0.003	estimated subj. model
$\bar{\alpha}^h$	-0.732	estimated subj. model	σ_r	0.004	estimated subj. model
λ	-0.037	estimated subj. model	σ_w	0.008	estimated subj. model

Choose remaining parameters to match average proportion on negative model, elasticity of that proportion to inflation, and average $\mathbb{E}_t^h \pi_t$ responsiveness to inflation shocks in IAS. $s.d.(\alpha) = 0.613, \alpha_1^h = -234, \mu = 0.787 \times 10^{-9}$

$\implies$ narrative heterogeneity channel lowers steady state $d\bar{c}_t / d\pi_t$ by **56%**, and increases its standard deviation by **65%**.

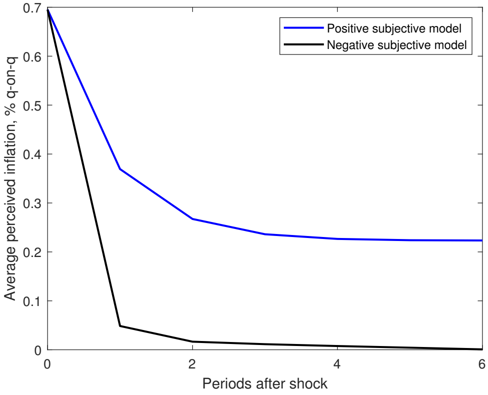
With endogenous $\bar{\pi}_t$ beliefs, 6 quarters after 1%pt π_t shock, $d\bar{c}_t / d\pi_t$ is 7% below steady state. 70% of this is due to the narrative heterogeneity channel.

Adding Endogenous Long-Run Expectations

Back

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

Make information decisions based on $\alpha_t^{h,prior} = \alpha_0^h + \alpha_1^h \mathbb{E}_{t-1}^h \bar{\pi}_t$



If start with **negative** model:

- $\pi_t \uparrow \implies \alpha^h \downarrow$ even more.
- Pay more attention, quickly adjust $\mathbb{E}_t \pi_t$ down after shock.

If start with **positive** model:

- $\pi_t \uparrow \implies \alpha^h \downarrow$ towards zero.
- Pay less attention, **do not** adjust $\mathbb{E}_t \pi_t$ down after shock.

$\mathbb{E}_{t-1}^h \bar{\pi}_t$ paths Empirical evidence

Should we worry about expectations becoming baked in? Back

Limited information only: X

Subjective models only: X

Both: ✓

- But only among those with (initially) positive models.
- Temporary shock $\Longrightarrow$ **persistent** change in the **narrative heterogeneity channel**.

Quantification

Information and Perceived Inflation Back

Model implications:

Negative subjective models:

- $\tilde{\mathbb{E}}_t^h \pi_t \uparrow \implies$ subjective model more negative.
- $\implies$ Corr (info, $\tilde{\mathbb{E}}_t^h \pi_t) > 0$

Positive subjective models:

- $\tilde{\mathbb{E}}_t^h \pi_t \uparrow \implies$ subjective model less positive.
- $\implies$ Corr (info, $\tilde{\mathbb{E}}_t^h \pi_t) < 0$

Table: Regression of perceived inflation on information by subjective model.

	$\tilde{\mathbb{E}}_t^h \pi_t$	$\tilde{\mathbb{E}}_t^h \pi_t$
Information	0.226^{**}	-0.122
	(0.102)	(0.138)
Subj. model	Negative	Non-negative
HH controls	Yes	Yes
Time FE	Yes	Yes
Observations	5114	2787

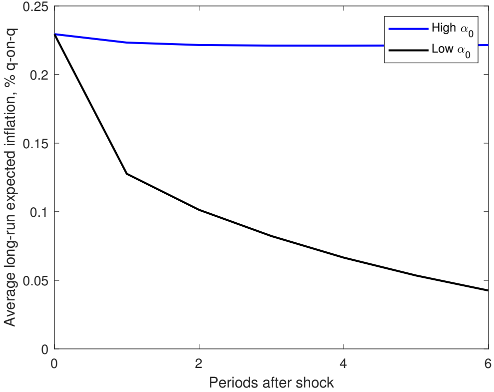
Standard errors in parentheses

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

Endogenous Long-Run Expectations Back

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

Make information decisions based on $\alpha_t^{h,prior} = \alpha_0^h + \alpha_1^h \mathbb{E}_{t-1}^h \bar{\pi}_t$



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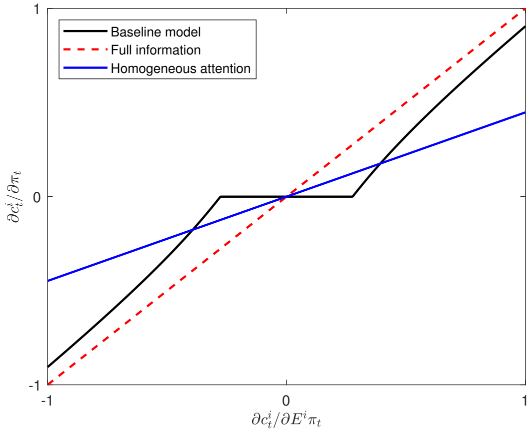
If start with **positive** model:

- $\pi_t \uparrow \implies \alpha^h \downarrow$ towards zero.
- Pay less attention, **do not** adjust $\bar{\pi}$ beliefs down after shock.

Implication: Selection in Information Back

Figure: Reaction to shock by subjective model



- The households who are attentive to inflation are the ones who would react strongest to information.
- Aggregate measures of inattention **overstate** aggregate effects of info. frictions.
- $\frac{d\bar{c}_t}{d\pi_t}$ closer to FI benchmark than if all HHs have average information.

Micro: large inattention in data (Link et al, 2021)
Macro: need small inattention (Maćkowiak and Wiederholt, 2015)

Implication: Selection in Information and RCTs Back

Recent trend: survey RCTs to estimate causal effects of expectations.

$$\begin{tikzcd}[column sep=small]
 & \text{Ask for } \mathbb{E} \arrow[dl] \arrow[dr] & \\
\text{Provide info} \arrow[dr] & & \text{No info} \arrow[dl] \\
 & \text{Ask } \mathbb{E} \text{ again} \arrow[d] & \\
 & \text{Measure outcome} &
\end{tikzcd}$$

Generate exogenous variation in $\mathbb{E}$ by instrumenting with $\mathbb{1}$(shown information).

- Estimates **local** effect on those who update the most.
- i.e. those who go in least informed, who have the lowest $dc/d\mathbb{E}\pi$.

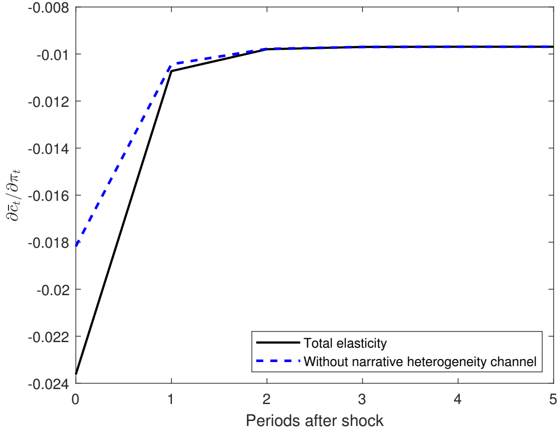
Is this the relevant group?

- Central bank communication: ✓
- Forward guidance/macro shocks: X

Implication: Time-Varying Shock Transmission Back

Figure: $\partial\bar{c}_t/\partial\pi_t$ after transitory 1% pt. π shock.

Calibration



- High $\pi_t \implies$ high perceived π_t
- $\implies$ more bias towards **negative** models of inflation.

Implication: Time-Varying Shock Transmission Back

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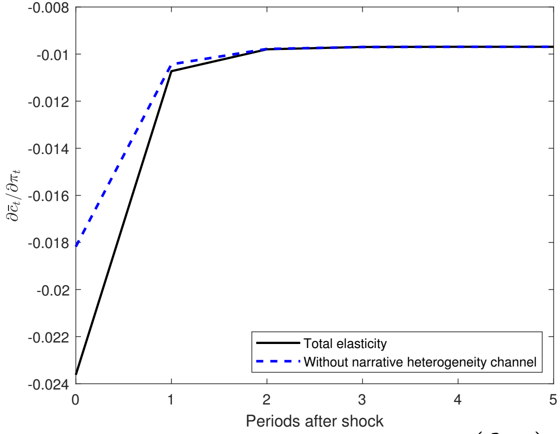


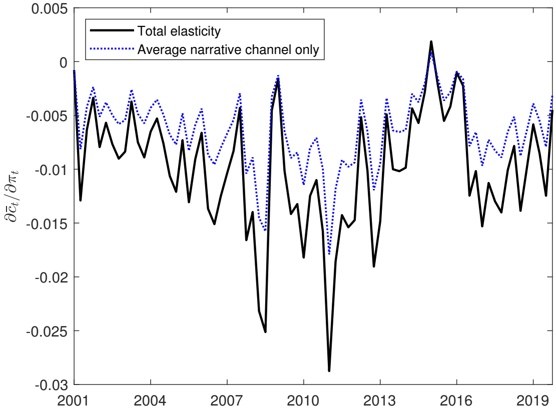
- High $\pi_t \implies$ high perceived π_t
- $\implies$ more bias towards **negative** models of inflation.
- Largest effect on those somewhat aware of the inflation - i.e. with somewhat negative models.
- $\implies$ **narrative het. channel** amplifies average effect.

Narrative heterogeneity increases $s.d.\left(\frac{\partial\bar{c}_t}{\partial\pi_t}\right)$ by **65%** Simulated elasticity time series

Implication: Time-Varying Shock Transmission Back

Feed in observed q-on-q CPI inflation series (de-meaned).

Figure: Simulated $\partial \bar{c}_t / \partial \pi_t$ over time. Calibration



Narrative heterogeneity increases $s.d.\left(\frac{\partial \bar{c}_t}{\partial \pi_t}\right)$ by **65%**