Rational Inattention Choices in Firms and Households

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Introduction

- **Expectations are central to decision making**
  - $\Rightarrow$ how households revise their expectations is central to their consumption decisions [Coibion et al. (2023)]
  - $\Rightarrow$ how firms revise their expectations is central to their pricing decisions [Born et al. (2022)]

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- **Heterogeneity in expectations across variables**
  - ⇒ focus on two classical macro variables: inflation and output [Candia et al. (2020)]

Heterogeneity in expectations across variables [based on Candia et al. (2020)]

- Households associate higher expected inflation with lower output growth – *supply side view*
- Firms/professionals associate higher future inflation with higher growth – *demand side view*

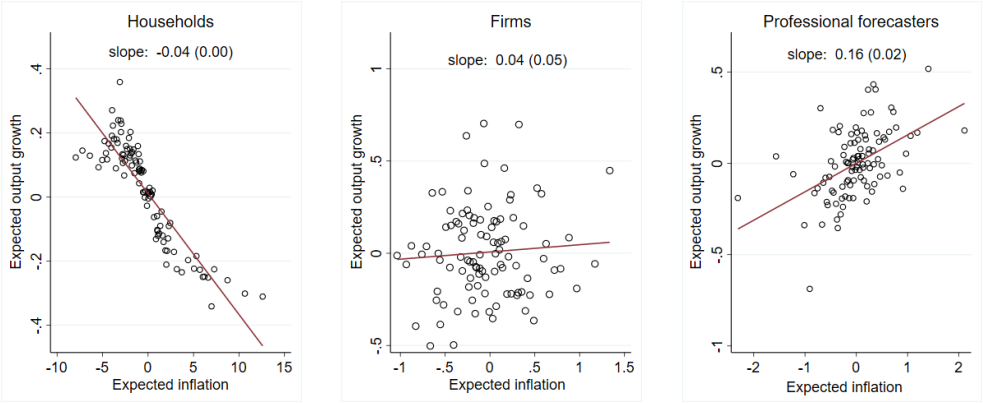

Figure 1: Correlation between expected inflation and expected output

Data Sources: Michigan Survey of Consumers; The Livingston Survey; The Survey of Professional

Unemployment | Simulation | Empirical Support

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This paper: *a unified expectation model based on rational inattention to rationalize the evidence*

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  - $\Rightarrow$ firms optimally pay slight more attention to demand shocks $\Rightarrow$ weak demand side view

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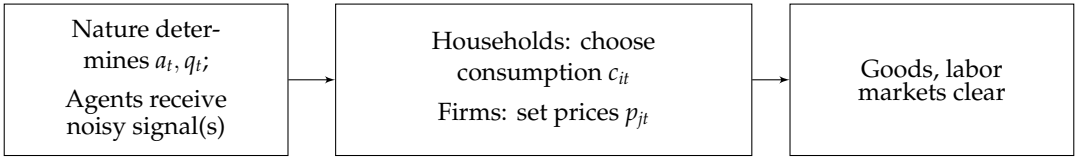
- A simple model with "rational inattention": agents choose what information to attend
  - $\Rightarrow$ households optimally pay more attention to supply shocks $\Rightarrow$ supply side view
  - $\Rightarrow$ firms optimally pay slight more attention to demand shocks $\Rightarrow$ weak demand side view
- A DSGE model to quantitatively match survey evidence
- Implications on business cycles and monetary policy *[Not today]*

A Simple Model

A simple model with rational inattentive firms and households:

- **Agents:** households make consumption decisions; firms make price decisions
- **Shocks:** productivity shocks (a_t) + monetary policy shock ($q_t \equiv \log Q_t = \log(P_t Y_t)$)
- **Information structure:** *ex ante* attention choices (initial period $t = 0$)

In each subsequent period $t > 0$



A Simple Model

Households. A continuum of hand-to-mouth households. Per period utility

$$\mathcal{U}_{it} = \mathbb{E}_{it}\left[\frac{C_{it}^{1-\gamma}}{1-\gamma} - \frac{L_{it}^{1+\eta}}{1+\eta}\right]$$

subject to

$$P_t C_{it} = W_t L_{it}$$

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$$P_t C_{it} = W_t L_{it}$$

$\Rightarrow$ Each period household i chooses consumption level C_{it} to maximize expected utility

Model

Households. A second-order approximation of household i expected utility Approx

$$u_{it} \propto \mathbb{E}_{it}\left[-\frac{\gamma+\eta}{2}\left(c_{it}-c_{it}^{*}\right)^{2}\right]$$

- where optimal consumption choice under full information: $c_{it}^{*}=\frac{1+\eta}{(\gamma+\eta)}\left(w_{t}-p_{t}\right)$

Model

Households. A second-order approximation of household i expected utility ▸ Approx

$$u_{it} \propto \mathbb{E}_{it}\left[-\frac{\gamma+\eta}{2}\left(c_{it}-c_{it}^{*}\right)^{2} - \mu^{h}\mathcal{I}\left(c_{it}^{*}; s_{it}\right)\right]$$

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Costly attention. Expected uncertainty reduction multiplied by marginal cost μ^{h} ▸ Entropy

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- Loss from not paying attention (benefit of paying attention) increases when optimal consumption varies significantly in response to certain shocks

Model

Firms. A continuum of firms, produce differentiated good $Y_{j,t}$ with a linear technology. Discounted expected profits

$$\mathcal{V}_{jt} = \mathbb{E}_{jt}\left[\frac{1}{P_t C_t}\Pi_{jt}\right], \quad \Pi_{jt} = P_{jt}Y_{jt} - \left(1-\theta^{-1}\right)W_t L_{jt}$$

the demand function for firm j's product

$$Y_{jt} = \left(\frac{P_{jt}}{P_t}\right)^{-\theta} Y_t$$

$\Rightarrow$ Each period firm j chooses price level P_{jt} to maximize expected profit

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Firms. A second-order approximation of firm j expected profit

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- Optimal price choice under full information: $p_{jt}^{*} = w_t - a_t$

Attention cost is the expected reduction of uncertainty times marginal cost μ^f

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Shocks. productivity shock $a_t \sim N\left(0, \sigma_a^2\right)$;
monetary policy shock $q_t \equiv \log Q_t = \log(P_t Y_t)$, $q_t \sim N\left(0, \sigma_q^2\right)$

Decision Problem

The households and firms face two choices in succession:

i. What type of information

Monetary Policy Shock | Productivity Shock | Beliefs under RI

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In line with the attention choices by households and firms in the survey

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ii. How much attention to pay depends on the responsiveness of optimal actions

Full information	Household i	Firm j
Monetary policy shock q_t	$c^*_{i,t} = 0$	$p^*_{j,t} = q_t$
Productivity shock a_t	$c^*_{i,t} = \frac{1+\eta}{\gamma+\eta} a_t$	$p^*_{j,t} = -\frac{1+\eta}{\gamma+\eta} a_t$

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"classical dichotomy"

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Quantitative Model

Extend the simple model in two dimensions **(Static → Dynamic)**:

1. Households can trade nominal bonds – intertemporal substitution
2. Central bank set interest rates following a Taylor rule
   - Central bank has full information
   - Model counterpart of the professional forecasters in the survey

Shocks. $AR(1)$ productivity process; $i.i.d$ shock to interest rates

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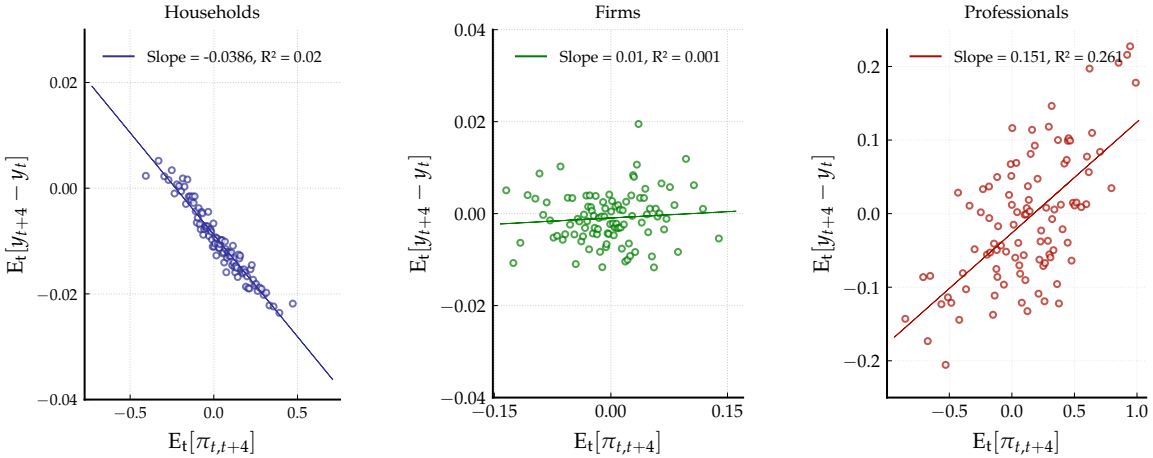
Shocks. $AR(1)$ productivity process; $i.i.d$ shock to interest rates

Intuition. Under full information, monetary policy shocks have no effect on real variables – classical dichotomy holds ⇒ households have limited incentive to pay attention to such shocks; Firms' problem same as before

▸ Households ▸ Full info ▸ Calibration ▸ Quantitative Results

Simulated Correlation

Figure 2: Correlation between expected inflation and expected output



Survey

Conclusion

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- Rational inattention lead to slow and asymmetric adjustment

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- Rational inattention lead to slow and asymmetric adjustment

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- A DSGE model with both agents subject to RI and prices adjust so that market clears

$\Rightarrow$ Rich interactions between rational inattentive households and firms

$\Rightarrow$ Matters for the transmission of shocks

The End
Thank You!

Disagreement in expectations across variables

- Households associate higher expected inflation with higher unemployment - *supply side view*
- Firms/professionals associate higher inflation with lower unemployment - *demand side view*

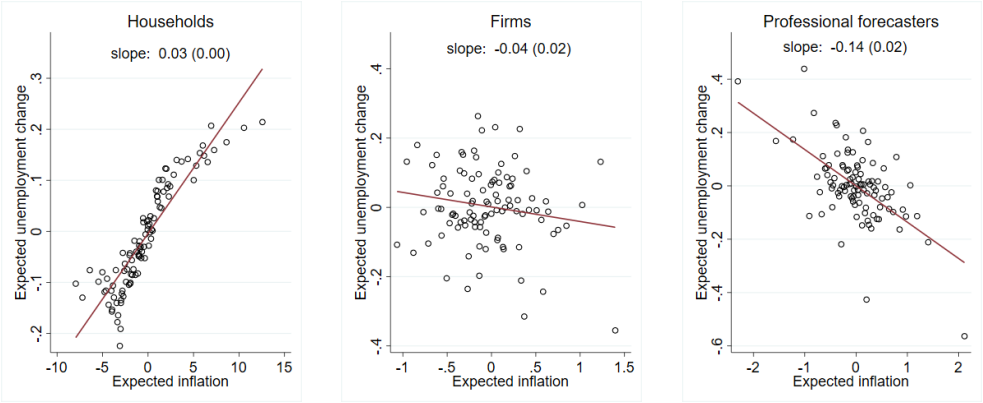

Figure 3: Correlation between expected inflation and expected unemployment change

Data Sources: Michigan Survey of Consumers; The Livingston Survey; The Survey of Professional Forecasters.

Back

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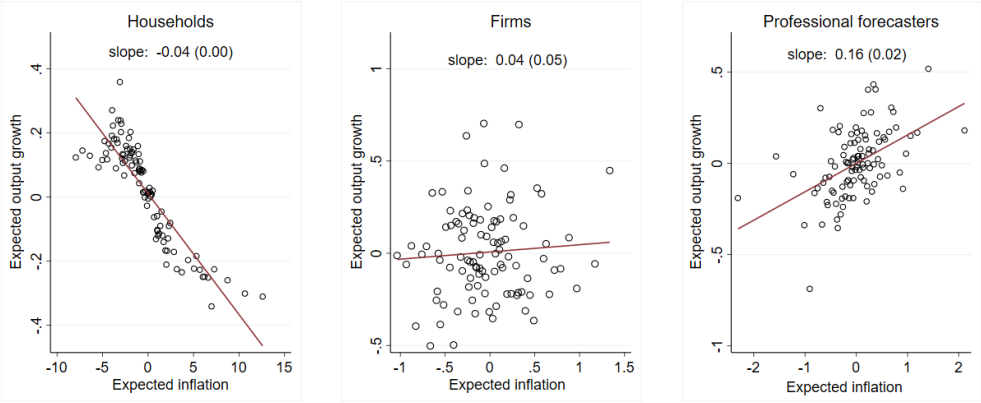

Figure 4: Correlation between expected inflation and expected output

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Unemployment Back

Evidence #1: Disagreement in expectations across variables

Table 1: Perceived Relationship between Expected Inflation and Expected Growth

	Growth Forecasts			
	Households		Firms	Professional
	Full Sample	Great Moderation		forecasters
Inflation Forecasts	-0.038^{***}	-0.034^{***}	0.039	0.156^{***}
	(0.001)	(0.001)	(0.049)	(0.023)
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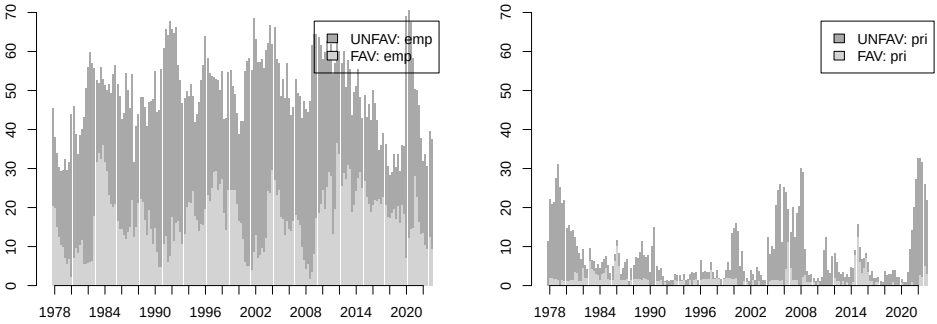
- Similar results also find in random control trials (Coibion et al., 2018, 2023)
- Negative correlation persisted even during Great Moderation

▸ Back

Evidence #2: Attention choices differ across agents

Michigan Survey of Consumers: *During the last few months, have you heard of any favorable or unfavorable changes in business conditions? What did you hear?*



(a) News about employment

(b) News about prices

Figure 5: Fraction of survey respondents having heard news in each category in last quarter

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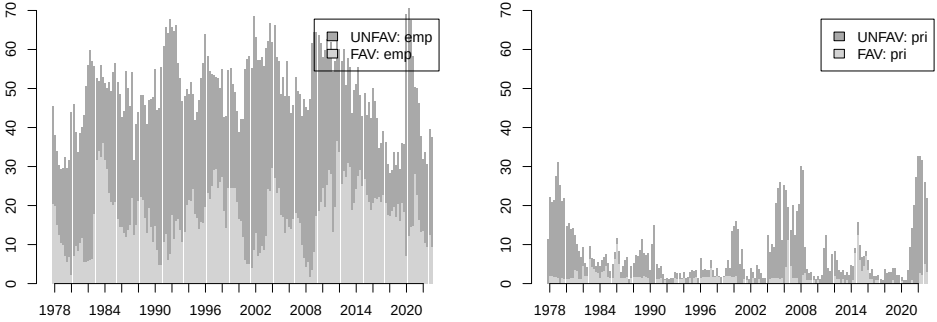

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$\Rightarrow$ Households are more attentive to changes in labor market conditions

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Business Inflation Expectations: *Projecting ahead over the next 12 months, how do you think the following five common influences will affect the prices of your products and/or services?*

- 72% of firms report nominal costs will have strong/moderate influence on their prices

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$\Rightarrow$ Firms when setting prices are more interested in knowing their nominal costs

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$$\mathbb{E}_t^i[\Delta y_{t+1}] = \beta_0 + \beta_1 \mathbb{E}_t^i[\pi_{t+1}] + \gamma_1 \mathbb{E}_t^i[\pi_{t+1}] \times News_{i,t}^{labor} + \gamma_2 \mathbb{E}_t^i[\pi_{t+1}] \times News_{i,t}^{price} + \alpha_1 News_{i,t}^{labor} + \alpha_2 News_{i,t}^{price} + u_{i,t}$$

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	Interpretation
$\gamma_x < 0$	Attention to that news x contributes to supply-side view
$\gamma_x > 0$	Attention to that news x contributes to demand-side view

Back

Evidence #3: Attention affects belief

Table 2: Perceived Relationship between Expected Inflation and Growth: Households

	Growth Forecasts		
	All	Labor news (+)	Labor news (–)
Inflation Forecasts	-0.047^{***}	-0.047^{***}	-0.047^{***}
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Inflation Forecasts × Labor news	-0.0186^{**}	-0.019^{**}	-0.013^{*}
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Inflation Forecasts × Price news	0.006	0.006	0.006
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Labor news	-0.091^{***}	0.152^{***}	-0.237^{***}
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Robust Back

Robustness

- **Households**: of 4,276 interviewed ≥ 3 times, 75.3% display a negative slope
- **Firms**: 54.3% positive, 45.7% negative
- **Professional forecasters**: 73.7% positive

Back

Robustness

Table 3: Perceived Relationship between Inflation and Growth: Households

	Inflation Forecasts		
	All	Price news (+)	Price news (-)
Growth Forecasts	-0.462^{***}	-0.462^{***}	-0.462^{***}
	(0.006)	(0.006)	(0.007)
Growth Forecasts × Labor news	-0.109^{*}	-0.109^{*}	-0.109^{*}
	(0.067)	(0.067)	(0.067)
Growth Forecasts × Price news	0.105	0.1274	0.129
	(0.253)	(0.275)	(0.255)
Labor news	−0.051	−0.051	−0.051
	(0.062)	(0.067)	(0.062)
Price news	−0.028	−0.195	−0.005
	(0.230)	(0.251)	(0.233)
Intercept	0.012	0.012	0.011
	(0.006)	(0.006)	(0.006)
Observations	218,716	218,716	218,716

Data Sources: Michigan Survey of Consumers.

Second Order Approximation – utility function

- Household per-period utility

$$U\left(C_{it}, P_t, W_t\right) = \frac{C_{it}^{1-\gamma}}{1-\gamma} - \frac{L_{it}^{1+\eta}}{1+\eta} =_{[1]} \frac{\left(C_{it}\right)^{1-\gamma}}{1-\gamma} - \frac{\left(\frac{P_t C_{it}}{W_t}\right)^{1+\eta}}{1+\eta} =_{[2]} \left[\frac{\left(\bar{C}e^{c_{it}}\right)^{1-\gamma}}{1-\gamma} - \frac{\left(\frac{\bar{P}e^{p_t}\bar{C}e^{c_{it}}}{\bar{W}e^{w_t}}\right)^{1+\eta}}{1+\eta}\right]$$

$=_{[1]}$ substitute labor using budget constraint $L_{it} = P_t C_{it}/W_t$; $=_{[2]}$ express as log-deviations

- Taking second-order approximation to the function $L\left(c_{it}, p_t, w_t\right) \equiv u\left(c_{it}, p_t, w_t\right) - u(c_{it}^*, p_t, w_t)$ around the steady state

$$L\left(c_{it}, p_t, w_t\right) \approx \frac{1}{2} u_{11}\left(c_{it}^2 - c_{it}^{*2}\right) + u_{12} p_t\left(c_{i,t} - c_{it}^*\right) + u_{13} w_t\left(c_{it} - c_{it}^*\right) \tag{A1}$$

- Note that since optimal consumption maximizes the utility function for any p_t and w_t

$$u_1(c_{it}^*, p_t, w_t) = 0 \Rightarrow u_{11} c_{it}^* + u_{12} p_t + u_{13} w_t \approx 0 \tag{A2}$$

- Combining Equation (A1) and (A2)

$$u\left(c_{it}, p_t, w_t\right) = L\left(c_{it}, p_t, w_t\right) + \hat{u}\left(c_{it}^*, p_t, w_t\right) = \frac{1}{2} u_{11}\left(c_{it} - c_{it}^*\right)^2 + \text{terms independent of } c_{it}$$

- Finally, $\hat{u}_1$ is the derivative of $\hat{u}$ w.r.t c_{it} and evaluated at the non-stochastic steady state. As c_{it} is choice variable, $\hat{u}_1 = 0$. And $\hat{u}_{11}$ is the second derivative of $\hat{u}$ w.r.t c_{it}, $\hat{u}_{11} = \gamma + \eta$ Back

Cost of Information

- Flow cost of information is measured as

$$\mu \mathbb{I}(X^t; \mathcal{S}^t | \mathcal{S}^{t-1})$$

- where $\mu > 0$ is a parameter (marginal cost of attention), and $\mathbb{I}(X^t; \mathcal{S}^t | \mathcal{S}^{t-1})$ the reduction in entropy of X^t by expanding knowledge from $\mathcal{S}^{t-1}$ to $\mathcal{S}^t$

$$\mathbb{I}(X^t; \mathcal{S}^t | \mathcal{S}^{t-1}) \equiv h(X^t | \mathcal{S}^{t-1}) - \mathbb{E}\left[h(X^t | \mathcal{S}^t) | \mathcal{S}^{t-1}\right]$$

- here $\{\mathcal{S}^t\}_{t \geq 0}$ denote the information sets for the agent at time t

- For example, consider a Gaussian white noise x with prior uncertainty σ_x^2

$$\mathbb{I}(x; \mathcal{S}) \equiv h(x) - \mathbb{E}\left[h(x|\mathcal{S})\right] = \frac{\log \sigma_x^2}{2\pi e} - \frac{\log \sigma_{x|s}^2}{2\pi e}$$

- here $\sigma_{x|s}^2 \geq \sigma_x^2$ is the posterior uncertainty of x upon reception of signal s

Firms' attention problem

- Households have full information, optimal price $p_{jt}^* = q_t$
- The rational inattention problem of firm j becomes

$$\max_{\{p_{jt} \in \mathcal{S}^t\}} \mathbb{E}\left[-\frac{(\theta-1)}{2}\left(p_{jt}-q_t\right)^2 - \mu^f \mathbb{I}\left(q_t; p_{jt}\right)|p_j^{-1}\right]$$

$$=_{[1]} \max_{\{p_{j,t} \in \mathcal{S}^t\}} \mathbb{E}\left[-\frac{(\theta-1)}{2}\left(\mathbb{E}\left(q_t|p_{jt}\right)-q_t\right)^2 - \mu^f \mathbb{I}\left(q_t; p_{jt}\right)|p_j^{-1}\right]$$

$$=_{[2]} \max_{\{\sigma^2_{q|s} \leq \sigma^2_q\}} \frac{1}{2}\left[-(\theta-1)\sigma^2_{q|s} - \mu^f \ln \frac{\sigma^2_q}{\sigma^2_{q|s}}\right]$$

$=_{[1]}$ substitute $p_{j,t} = \mathbb{E}[p^*_{j,t}|s_{j,t}] = \mathbb{E}[w_t|s_{j,t}]$, $=_{[2]}$ posterior variance $\sigma^2_{q|s} = \mathbb{E}[(\mathbb{E}(q_t|p_{j,t}) - q_t)^2]$

- F.O.C $\Rightarrow$ posterior uncertainty $\Rightarrow$ Kalman gain

$$\sigma^2_{q|s} = \min\left(\sigma^2_q, \frac{\mu^f}{(\theta-1)}\right), \quad \xi^f_q \equiv 1 - \frac{\sigma^2_{q|s}}{\sigma^2_q}$$

  - A signal is worthwhile if σ^2_q large, μ^f small, or $(\theta-1)$ large

Back

The Case with Demand Shocks

- **Full information baseline.**

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- **Rational inattentive firms.**
  - Firms compare the cost and benefit of paying attention Solution

$$\max_{\{p_{jt} \in \mathcal{S}_j^t\}_{t \geq 0}} \mathbb{E}^j \left[\underbrace{-\frac{\theta - 1}{2} \left(p_{j,t} - w_t \right)^2}_{\text{benefit: improve precision}} - \underbrace{\mu^f \mathbb{I} \left(w_t ; p_{jt} \right)}_{\text{cost of attention}} \left| p_j^{-1} \right. \right]$$

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  - Firms under-react to the aggregate nominal demand shock $p_t = \xi_q^f w_t$, where $\xi_q^f \equiv \max\{0, 1 - \underline{\sigma}_f^2 / \sigma_q^2\} \in [0, 1]$ reflects the chosen level of attention

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$\Rightarrow$ Real wage varies due to firms' attention error $w_t - p_t = (1 - \xi_q^f) w_t$

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$\Rightarrow$ Real wage varies due to firms' attention error $w_t - p_t = (1 - \xi_q^f) w_t$
$\Rightarrow$ Information on demand shock becomes valuable for households

Back

The Case with Demand Shocks

- **Rational inattentive households.**
  - Households compare cost and benefit of paying attention

$$\max_{\{c_{it}\in\mathcal{S}_h^t\}_{t\geq 0}} \mathbb{E}^i\left[-\frac{(\gamma+\eta)}{2}\left(c_{it}-\frac{1+\eta}{\gamma+\eta}(\overbrace{w_t-p_t}^{\text{firms' error}})\right)^2-\mu^h\mathbb{I}\left(c_{it}^*;c_{it}\right)|c_i^{-1}\right]$$

  - Households' consumption slightly increases $c_t=\xi_q^h\left[\frac{1+\eta}{\gamma+\eta}\left(w_t-p_t\right)\right]$, ξ_q^h attention level

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*So far take w_t as given, but **endogenous** to attention choices and decisions by firms and households* Back

Results #1: Households pay limited attention to demand shocks

- Households are naturally insured against demand shocks as firms will set prices to closely track nominal wage, and thus not much variation in real wage

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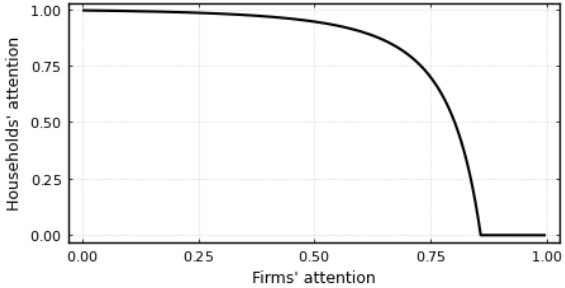
- Households are naturally insured against demand shocks as firms will set prices to closely track nominal wage, and thus not much variation in real wage

$\Rightarrow$ Households don't pay attention unless firms make big mistakes – substitutes



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The Case with Supply Shocks

- **Full information baseline.**
  - Positive productivity shock, price decreases on impact $p_t = w_t - a_t = -\frac{1+\eta}{\gamma+\eta} a_t$
  - A surge in demand $c_t = \frac{1+\eta}{\gamma+\eta} a_t$

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- **Full information baseline.**
  - Positive productivity shock, price decreases on impact $p_t = \overset{\uparrow}{w_t} - \overset{\uparrow}{a_t} = -\underbrace{\frac{1+\eta}{\gamma+\eta}}_{<1} a_t$
  - A surge in demand $c_t = \frac{1+\eta}{\gamma+\eta} a_t$
  - If income effect dominates $\Rightarrow$ labor supply $\downarrow$ wage $\uparrow$

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- **Rational inattentive firms.**

$$\max_{\{p_{jt} \in \mathcal{S}_f^t\}_{t \geq 0}} \mathbb{E}_{jt}\left[-\frac{\theta - 1}{2} \left(p_{jt} - (w_t - a_t) \right)^2 - \mu^f \mathbb{I}\left(p_{jt}^*; p_{jt} \right) | p_j^{-1} \right]$$

  - Firms under-react to productivity shock $p_t = \xi_a^f (w_t - a_t)$, where $\xi_a^f \in [0, 1]$ reflects the chosen level of attention
  - Under-react even more if labor are relatively elastic ($w_t \uparrow$ more)

Back

The Case with Supply Shocks

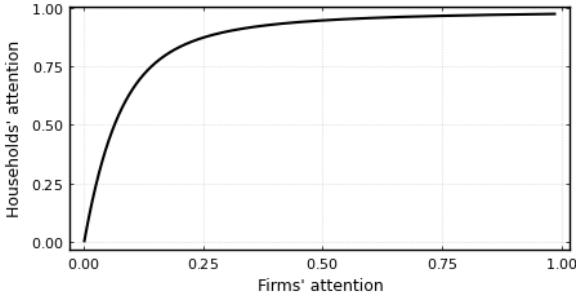
- **Rational inattentive households.**
  - Information on supply shock is particularly valuable for households as $w_t \uparrow$ and $p_t \downarrow$

$$\max_{\{c_{it} \in \mathcal{S}_h^t\}_{t \geq 0}} \mathbb{E}_{it} \left[-\frac{(\gamma + \eta)}{2} \left(c_{it} - \frac{1 + \eta}{\gamma + \eta} (w_t - p_t) \right)^2 - \mu^h \mathbb{I} \left(c_{it}^*; c_{it} \right) | c_i^{-1} \right]$$

  - Change in real wage more significant if firms pay high attention
  - Aggregate consumption $c_t = \frac{1+\eta}{(\gamma+\eta)} \xi_a^h \left[\left(1 - \xi_a^f \right) w_t + \xi_a^f a_t \right]$

Results #2: Both pay attention to supply shocks

- Both households and firms pay attention to supply shocks
- Less important for firms if labor is elastic
- Attention choices by households and firms are complements



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Attention Choices on Beliefs

- True data generating process

$$y_t = \Psi_{y,q} q_t + \Psi_{y,a} a_t,$$
$$p_t = \Psi_{p,q} q_t - \Psi_{p,a} a_t. \qquad \text{(DGP)}$$

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- Perceived data generating process

$$\mathbb{E}^i y_t = \Psi_{y,q} \xi_q(i) q_t + \Psi_{y,a} \xi_a(i) a_t + e_t^i,$$
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where $\xi_q(i)$ and $\xi_a(i) \in [0, 1]$ are attention weights on q_t and a_t, e and ν are errors

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Covariance between expected output growth and expected inflation

$$Cov\left(\mathbb{E}^i(y_{t+1} - y_t), \mathbb{E}^i(\pi_{t+1})\right) = \Psi_{y,q}\Psi_{p,q}\xi_q(i)^2\sigma_q^2 - \Psi_{y,a}\Psi_{p,a}\xi_a(i)^2\sigma_a^2$$

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- Rational inattentive households: $\xi_q \ll \xi_a$ – negative Cov

Attention Choices on Beliefs

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- Full information: $\xi_q(i) = \xi_a(i) = 1$
- Rational inattentive households: $\xi_q \ll \xi_a$ – negative Cov
- Rational inattentive firms: $\xi_q \lessgtr \xi_a$ – weak Cov

Back

Households' attention problem

$$\max_{\{C_{i,t},B_t,L_t\}} \mathbb{E}_{it}\left[\sum_{t=0}^{\infty}\beta^t\left(\frac{C_{i,t}^{1-\gamma}}{1-\gamma}-\frac{L_{i,t}^{1+\eta}}{1+\eta}\right)\right] \tag{A3}$$

$$s.t.\ P_tC_{i,t}+B_{i,t}=W_tL_{i,t}+R_{t-1}B_{i,t-1}+D_t+T_t,\quad C_{i,t}=\left[\int_0^1 C_{i,j,t}^{\frac{\theta-1}{\theta}}dj\right]^{\frac{\theta}{\theta-1}}$$

Household i chooses $v_t\equiv(\tilde{b}_{i,t},c_{i,t})'$. A log-quadratic approximation of Eq. (A3)

$$\sum_{t=0}^{\infty}\beta^t\mathbb{E}_i^h\left[\frac{1}{2}\left(v_t-v_t^*\right)'\Theta_0\left(v_t-v_t^*\right)+\left(v_t-v_t^*\right)\Theta_1\left(v_{t+1}-v_{t+1}^*\right)\right]$$

with optimal actions path

$$\omega_B\left(\frac{1}{\beta}\tilde{b}_{i,t-1}^*-\tilde{b}_{i,t}^*\right)+c_{i,t}^*=\mathbb{E}_t\left[\omega_B\left(\frac{1}{\beta}\tilde{b}_{i,t}^*-\tilde{b}_{i,t+1}^*\right)+c_{i,t+1}^*\right]$$

$$-\omega_B\left(\frac{1}{\beta}\tilde{b}_{i,t-1}^*-\tilde{b}_{i,t}^*\right)+\left(\gamma\frac{\omega_W}{\eta}+1\right)c_{i,t}^*=\omega_W\left(\frac{1}{\eta}+1\right)\tilde{w}_t+\left[\frac{1}{\beta}\omega_B\left(i_{t-1}-\pi_t\right)+\omega_D\tilde{d}_t+\omega_T\tilde{\tau}_t\right]$$

Households' attention problem

$$\sum_{t=0}^{\infty} \beta^t \mathbb{E}_i^h \left[\frac{1}{2} \left(v_t - v_t^* \right)' \Theta_0 \left(v_t - v_t^* \right) + \left(v_t - v_t^* \right) \Theta_1 \left(v_{t+1} - v_{t+1}^* \right) \right]$$
$$= \sum_{t=0}^{\infty} \beta^t \mathbb{E}_{i,-1} \left[\frac{1}{2} \left(x_{i,t} - x_{i,t}^* \right)' \Theta \left(x_{i,t} - x_{i,t}^* \right) \right]$$

Instead of choosing directly $v_t = (\tilde{b}_{i,t}, c_{i,t})'$, I assume the household i chooses

$$x_{i,t} = \begin{pmatrix} \omega_B \left(\tilde{b}_{i,t} - \tilde{b}_{i,t-1} \right) \\ -\omega_B \left(\frac{1}{\beta} \tilde{b}_{i,t-1} - \tilde{b}_{i,t} \right) + \left(\gamma \frac{\omega_W}{\eta} + 1 \right) c_{i,t} \end{pmatrix}$$

And the optimal choice of $x_{i,t}^*$ under full information is

$$x_{i,t}^* = \begin{pmatrix} z_t - (1-\beta) \sum_{s=t}^{\infty} \beta^{s-t} \mathbb{E}_t \left[z_s \right] + \frac{\beta}{\gamma} \left(1 + \omega_W \frac{\gamma}{\eta} \right) \sum_{s=t}^{\infty} \beta^{s-t} \mathbb{E}_t \left(i_s - \pi_{s+1} \right) \\ \omega_W \left(\frac{1}{\eta} + 1 \right) \tilde{w}_t + \left[\frac{1}{\beta} \omega_B \left(i_{t-1} - \pi_t \right) + \omega_D \tilde{d}_t + \omega_T \tilde{\tau}_t \right] \end{pmatrix}$$

Here $z_t \equiv \omega_W \left(1 + \frac{1}{\eta} \right) \tilde{w}_t + \frac{1}{\beta} \omega_B \left(i_{t-1} - \pi_t \right) + \omega_D \tilde{d}_t + \omega_T \tilde{\tau}_t$ ◂ Back

Full information benchmark

Under full information, the equilibrium consumption and labor are

$$c_t = \frac{1+\eta}{\gamma+\eta} a_t, \qquad l_t = \frac{1-\gamma}{\gamma+\eta} a_t$$

The real interest rate is determined by the Euler Equation

$$r_t \equiv i_t - \mathbb{E}_t\left(\pi_{t+1}\right) = -\gamma \frac{1+\eta}{\gamma+\eta}\left(1-\rho_a\right) a_t$$

Then the monetary policy will determine the nominal variables. Back

Calibration

Table 4: Calibrated Parameters

Parameter	Value	Moment Matched / Source
Time discount factor (β)	0.99	Quarterly frequency
Elasticity of substitution across firms (θ)	10	Firms' average markup
Risk aversion coefficient (γ)	3.5	Households' risk aversion level
Inverse of Frisch elasticity (η)	2.5	Aruoba et al. (2017)
Taylor rule: smoothing (ρ)	0.936	Estimates 1985-2017 based on Tealbook forecast
Taylor rule: response to inflation (ϕ_π)	1.62	Estimates 1985-2017 based on Tealbook forecast
Taylor rule: response to output gap (ϕ_x)	0.225	Estimates 1985-2017 based on Tealbook forecast
Persistence of productivity shocks (ρ_a)	0.93	Estimates 1981-2022 based on Fernald (2014)
S.D of productivity shocks (σ_a)	0.0086	Estimates 1981-2022 based on Fernald (2014)
S.D of monetary shocks (σ_q)	0.0041	Estimates 1985-2017 based on Tealbook forecast

Solve for a grid values of attention cost parameters for households (μ^h) and firms (μ^f)

$$\mu^h = 0.4 \times 10^{-2}; \quad \mu^f = 0.4 \times 10^{-3};$$

Quantitative Results

Table 5: Moments in the Model and the Data

Moment	Data	95% conf. interval	Model
Slope coef. of HHs' expectations	-0.038	[-0.039, -0.037]	-0.038
Slope coef. of Firms' expectations	0.039	[-0.042, 0.120]	0.010
Slope coef. of Professionals' expectations	0.156	[0.111, 0.200]	0.151
R-squared value of HH's expectations	0.022	-	0.020
R-squared value of Firms's expectations	0.002	-	0.001
R-squared value of Professionals' expectations	0.016	-	0.261
P-value of HH's expectations	0.000***	-	0.000***
P-value of Firm's expectations	0.428	-	0.320
P-value of Professionals' expectations	0.000***	-	0.000***

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