Rationally Inattentive Heterogenous Agent

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Introduction

- **Information frictions** can help explain empirical macroeconomic regularities,
  - Delayed and persistent responses of aggregate variables.
  - Autocorrelated forecast errors.
  - Dispersed expectations.
- Rational Inattention (RI) microfounds these frictions.
  - Few GE applications, typically with ex-ante identical Ricardian households

Introduction

- **Household heterogeneity** matters for macroeconomic dynamics,
  - Transmission mechanisms.
  - Amplification effects.
  - Policy experiments.
- Shortcomings,
  - Under FIRE, no heterogeneity in expectations. (communism for expectations)
  - High MPC agents problematic for macro "humps".
  - Cross-sectional responses to shocks are largely unobserved.

"... the effects of household heterogeneity can be largely understood by looking at the differential behavior of two types of households: hand-to-mouth and unconstrained." Debortoli and Galí (2024)

Reasearch Questions

(i) Are households expectations systematically correlated with economic characteristics (HtM status)?

(ii) In business cycles models, can **rational inattention**

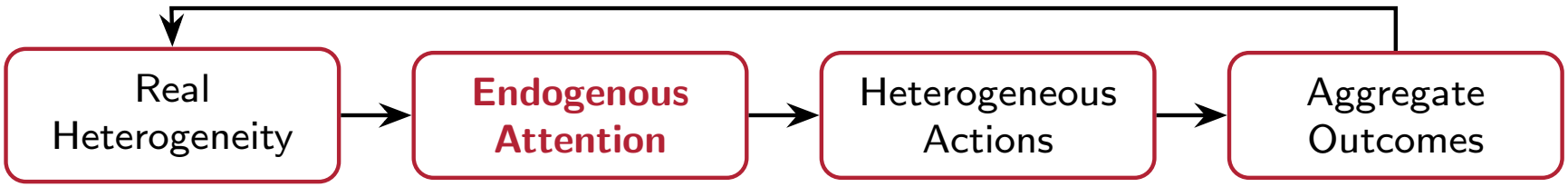
- explain cross-sectional differences in expectations? (micro moments)
- improve the fit of aggregate variables? (macro moments)

This Paper

- In survey data, HtM inflation forecast errors are 0.56–1.73 p.p. larger than those of other households.
- In two-agent models, the effects of household inattention depend largely on the labor market structure.
  - Competitive labor market fit micro but not macro moments; for households with market power the opposite occurs.
  - The relevance of heterogeneity (inequality dynamics) differ across models.
  - Insights favor labor market structures wherein unions and/or firms with monopsony power set wages.

The Attention Channel

"Real" heterogeneity shapes incentives to learn about the state of the economy,



The consequences of the **attention channel** are non-trivial,

- Losses from mistakes depend on marginal utility of consumption.
- Relevant information depends on the number and type of actions.
- Etc.

Related Litterature

- HA models with endogenous attention,
  - Expectation and Wealth Heterogeneity in the Macroeconomy, Mitman et al. (2022).
  - Firm inattention and the efficacy of monetary policy: A text-based approach, Song and Stern (2020).
- RI-DSGE,
  - Maćkowiak and Wiederholt (2015, 2023),
  - Afrouzi and Yang (2021).
- Two-agent models,
  - Bilbiie (2008, 2020),
  - Debortoli and Galí (2024).

Households' Measured Expectations

Data

Survey of Consumers Expectations:

- Monthly panel survey held by the NYFed.
- 1300 US households, each stays for 12M in the panel.
- Expectations about future state of the economy (fixed horizons).
- Households' characteristics (education, wage income, numeracy, etc.).
- Sample: 2013M6 to 2024M4.
- Supplemental surveys: **spending**, **credit**, finances, etc.

Identifying HtM Households

1. Negative Income Shock

Q: *Now imagine that next year you were to find yourself with 10% less household income. What would you do?*

1. **Cut spending by the whole amount**
2. Not cut spending at all, but cut my savings by the whole amount
3. Cut spending by some and cut savings by some (...)

2. Liquidity Constraint

Q: *What do you think is the % chance that you could come up with 2,000$ if an unexpected need arose within the next month?* **(treshold is set below 30%)**

3. Default Probability

Q: *What do you think is the % chance that, over the next 3 months, you will NOT be able to make one of your debt payments?* **(treshold is set above 70%)**

Some descriptive statistics.

Inflation Expectations Relative Accuracy

	Negative Income Shock	Liquidity Constraint	Default Probability
	-	-	-
Hand-to-mouth	0.563***	1.734***	1.731***
	(0.030)	(0.038)	(0.071)
High School	-	-	-
Some College	−0.732***	−0.751***	−0.862**
	(0.038)	(0.039)	(0.035)
College	−1.848***	−1.764***	−2.178***
	(0.038)	(0.040)	(0.035)
Low Numeracy	-	-	-
High Numeracy	−2.087***	−2.061***	−2.474***
	(0.033)	(0.035)	(0.030)
Unemployed	-	-	-
Part-time employed	0.041	0.107**	−0.013
	(0.048)	(0.050)	(0.044)
Full-time employed	−0.508***	−0.399***	−0.552***
	(0.033)	(0.034)	(0.030)
Observations	109,879	112,972	156,160
F Statistic	1783.44	2306.78	2981.38
R^2	0.112	0.133	0.125
Time Fixed Effects	yes	yes	yes

Notes: Estimates from regressions of the absolute value of inflation forecast errors on HtM status. Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Sample: 2013M8-2025M1.

Models

Overview

RI-DSGE,

- To observe (partially) the state of the economy, one must pay attention. No free lunch!
  - Processing information requires a cognitive effort (mental cost).
  - Deviations from optimal actions incur losses.
- Propagation mechanism: information frictions (learning).
- Equilibrium (fixed-point): consistency between attention allocation, individual actions, and aggregate dynamics.

2 Baseline Models,

- RI-I: Competitive wage.
- RI-II: Households with market power.

Environment: Firms

- Continuum $i \in [0, 1]$ of monopolistically competitive firms.
- Production: $Y_{it} = e^{a_t} e^{a_{it}} L_{it}^{\alpha}$, with $\alpha \in (0, 1]$.
- Dividends: $D_{it} = (1 + \tau_P) P_{it} Y_{it} - W_t L_{it}$.
- Aggregate productivity: $a_t = \rho_A a_{t-1} + \varepsilon_t^A, \quad \varepsilon_t^A \sim N(0, \sigma_A^2)$.

Environment: Households

- Continuum $j \in [0,1]$ of households of two types $h \in \{\mathcal{H}, \mathcal{S}\}$.
- Preferences: $U(C_{jt}, L_{jt}) = \frac{C_{jt}^{1-\gamma}-1}{1-\gamma} - \varphi^h \frac{L_{jt}^{1+\psi}}{1+\psi}$. $\gamma > 0$, $\psi \geq 0$, $\beta \in (0,1)$.
- Composite consumption: $C_{jt} = \left(\int_0^1 C_{ijt}^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}}$.
- Households $j \in [0, \phi]$ are HtM ($h = \mathcal{H}$).
- For all j of type $\mathcal{H}$: $\int_0^1 P_{it} C_{ijt} di = W_{jt} L_{jt} - T^{\mathcal{H}}$.
- For all j of type $\mathcal{S}$: $\int_0^1 P_{it} C_{ijt} di + B_{jt} = W_{jt} L_{jt} + R_{t-1} B_{jt-1} + D_t^{\mathcal{S}} - T_t^{\mathcal{S}}$.

Environment: Government

- Monetary Policy,
  - Taylor Rule, $\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_R} \left[\left(\frac{\Pi_t}{\Pi}\right)^{\phi_\pi} \left(\frac{Y_t}{Y_t^*}\right)^{\phi_{y^*}}\right]^{1-\rho_R} e^{\varepsilon_t^v}$.
  - $\varepsilon_t^v \sim N(0, \sigma_v^2)$.
- Fiscal Policy,
  - $T_t + B_t = R_{t-1} B_{t-1} + \tau_P \int_0^1 P_{it} Y_{it} di$.
  - Non-explosive path for real bonds.

Environment: Approximation

Discounted profits and utility, approx. with 2^{nd} order log Taylor expansions around the nsss.

- Quadratic objectives.
  (expected losses from suboptimal actions are of second-order)
- Linear laws of motion for the state and mappings for optimal actions.

$\Rightarrow$ Given Gaussian signals, optimal actions are determined via Kalman filtering.

Attention Problems

$$\max_{\boldsymbol{\Gamma},\boldsymbol{\Sigma}_\nu} \left\{ \sum_{t=0}^{\infty} \beta^t E_{-1} \left[\frac{1}{2} (\boldsymbol{x}_t - \boldsymbol{x}_t^*)' \boldsymbol{\Theta} (\boldsymbol{x}_t - \boldsymbol{x}_t^*) \right] - \lambda \sum_{t=0}^{\infty} \beta^t I(\boldsymbol{\xi}_t; \boldsymbol{S}_{it} | \mathcal{I}_{it-1}) \right\} \quad (1)$$

subject to

$$\boldsymbol{\xi}_{t+1} = \boldsymbol{F}\boldsymbol{\xi}_t + \boldsymbol{\mu}_{t+1} \ , \ \boldsymbol{\mu_{t+1}} \sim N(\boldsymbol{0}, \boldsymbol{\Sigma}_\mu) \quad (2)$$

$$\boldsymbol{x}_t^* = \boldsymbol{G}\boldsymbol{\xi}_t \quad (3)$$

$$\mathcal{I}_{it} = \mathcal{I}_{i,-1} \cup \{\boldsymbol{S}_{i0}, ..., \boldsymbol{S}_{it}\} \quad (4)$$

$$\boldsymbol{S_{it}} = \boldsymbol{\Gamma}\boldsymbol{\xi}_t + \boldsymbol{\nu_{it}} \ , \ \boldsymbol{\nu_{it}} \sim N(\boldsymbol{0}, \boldsymbol{\Sigma}_\nu) \quad (5)$$

$$I(\boldsymbol{\xi}_t; \boldsymbol{S_{it}} | \mathcal{I}_{it-1}) = H(\boldsymbol{\xi}_t | \mathcal{I}_{it-1}) - H(\boldsymbol{\xi}_t | \mathcal{I}_{it}). \quad (6)$$

$$\boldsymbol{x}_t = E[\boldsymbol{x}_t^* | \mathcal{I}_{it}]. \quad (7)$$

Equilibrium

In periods $t = 0, 1, 2, ...$

- Households maximize given their information set.
- Firms maximize given their information set.
- Markets clear.
- Agent's perceived law of motion of the economy are consistent with the actual law of motion (rational expectations).

In period -1,

- Prior uncertainty, $\Sigma_{0|-1}$, is at the s.s. value implied by $\{\Gamma^*, \Sigma_\nu^*\}$ $\forall i, j$.

Numerical solution method

Baseline Models: Losses from Suboptimal Actions

Firms set a price, p_{it}, for their variety.

* $\Theta_i = -(C^{\mathcal{S}})^{-\gamma} Y \left[\frac{\tilde{\theta}(\tilde{\theta}+\alpha(1-\tilde{\theta}))}{\alpha}\right]$

RI-I: Competitive Labor Market.

Every household supply labor, l_{jt}, $h = \mathcal{S}$ choose consumption, c_{jt}.

* $\Theta_j^{\mathcal{H}} = -(C^{\mathcal{H}})^{1-\gamma} \left[\omega_W^{\mathcal{H}}(\omega_W^{\mathcal{H}}\gamma + \psi)\right]$
* $\Theta_j^{\mathcal{S}} = -(C^{\mathcal{S}})^{1-\gamma} \begin{bmatrix} \gamma & 0 \\ 0 & \omega_W^{\mathcal{S}}\psi \end{bmatrix}$

RI-II: Households with Market Power.

Every household set a wage, w_{jt}, $h = \mathcal{S}$ choose consumption, c_{jt}.

* $\Theta_j^{\mathcal{H}} = -(C^{\mathcal{H}})^{1-\gamma} \left[\tilde{\eta}\omega_w^{\mathcal{H}}(1 + \tilde{\eta}(\gamma\omega_w^{\mathcal{H}} + \psi))\right]$
* $\Theta_j^{\mathcal{S}} = -(C^{\mathcal{S}})^{1-\gamma} \begin{bmatrix} \gamma & 0 \\ 0 & \tilde{\eta}\omega_W(1 + \tilde{\eta}\psi) \end{bmatrix}$

Estimation

Strategy

Period: 1969Q1-2019Q4.

- **Calibration**,
  - Structural parameters: business cycles litterature and financial survey data (*Survey of Consumers Finances*).
  - Exogenous shocks: model-consistent estimates from the data.

- **Estimation**,
  - Marginal costs of attention: "moment matching".
    - λ_i: serial correlation of inflation.
    - λ_j: serial correlation of output growth.
      (**homogenous across households**)

More details on heterogeneity parameters.

Parameters

Panel A: Calibrated Parameters

Parameter		Value
β	Discount factor	0.99
γ	EIS	1.5
ψ	Inverse Frisch	1.0
α	Labor share	0.66
$\tilde{\theta}$	Price elasticity of demand	4.0
$\tilde{\eta}$	Wage elasticity of demand	4.0
ϕ	HtM share	0.28
$\frac{C^S}{C^{\mathcal{H}}}$	Steady-state consumption ratio	1.4
ρ_r	Taylor rule inertia	0.9
ϕ_π	Taylor rule coefficient (inflation)	1.5
ϕ_{y^*}	Taylor rule coefficient (output gap)	0.125
ρ_a	Persistence of aggregate technology	0.95
$100\sigma_a$	100× S.D. of aggregate technology shocks	0.8
$100\sigma_v$	100× S.D. of monetary policy shock	0.2

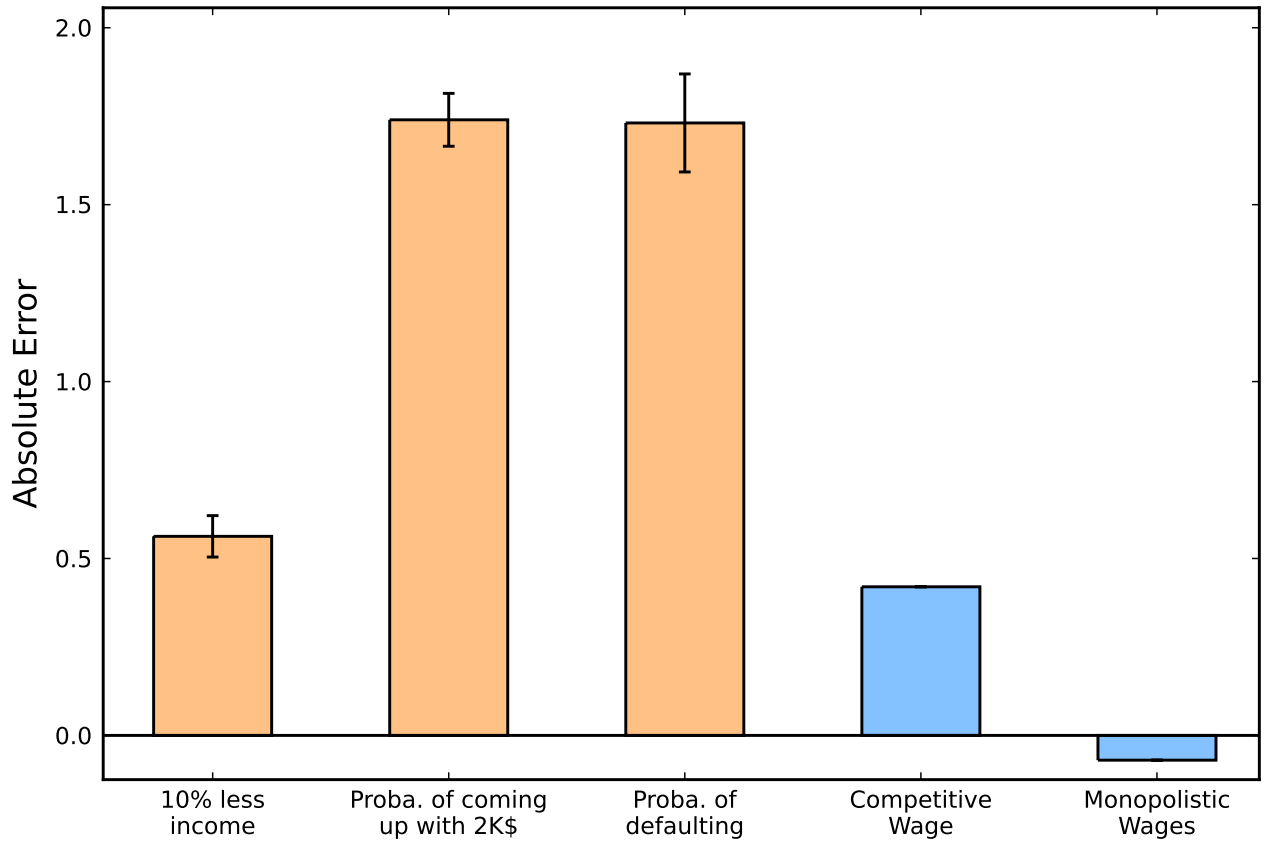
Panel B: Inattention Parameters

Parameter		Value
RI-I: competitive-wage		
λ_j	Firms marginal cost of attention	485.0
λ_j	Households marginal cost of attention	0.8
RI-II: monopolistic-wage		
λ_j	Firms marginal cost of attention	33.0
λ_j	Households marginal cost of attention	5.8
RI-F: inattentive firms, attentive households		
λ_j	Firms marginal cost of attention	360.0

Numerical values for losses from suboptimal actions.

Results

Inflation Expectations Relative Accuracy

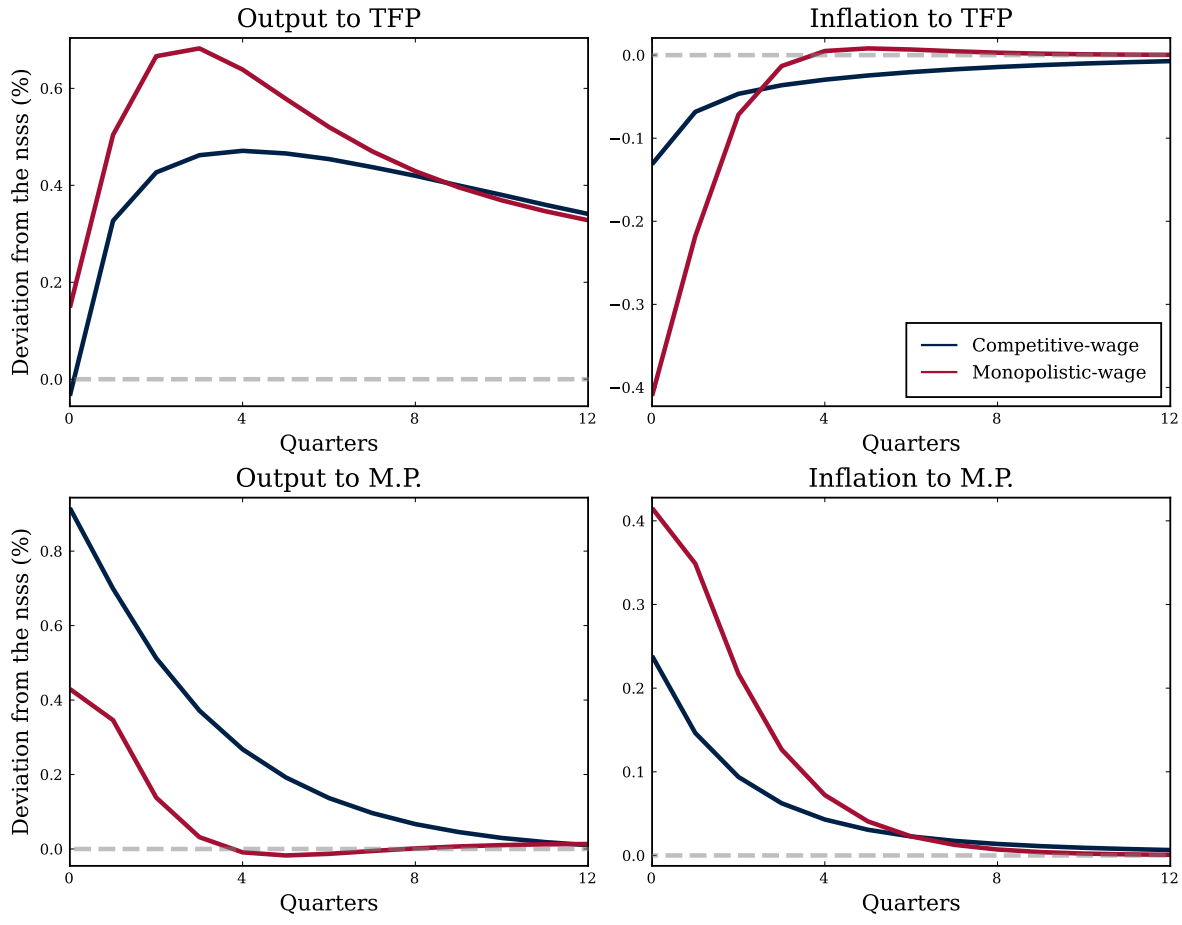


Unconditional Moments

	Data	RI-I	RI-II	RI-F	PI
Targeted Moments					
ρ_{π}	0.62	0.62	0.62	0.62	0.023
$\rho_{\Delta y}$	**0.3**	**-0.06**	**0.3**	-0.14	-0.025
Untargeted Moments					
$\rho_{\Delta w}$	0.48	-0.20	0.63	-0.18	-0.025
$\sigma_{\pi}/\sigma_{\Delta y}$	1.06	0.33	1.15	0.37	1.17
$\sigma_{\Delta w}/\sigma_{\Delta y}$	1.10	3.72	0.80	3.07	2.81
$\beta_{\pi,\mathcal{H}}$	1.73	0.42	-0.07	-	-

Notes: RI-I: competitive-wage. RI-II: monoplistic-wagew. RI-F: only firms s.t. RI.

Conditional Moments

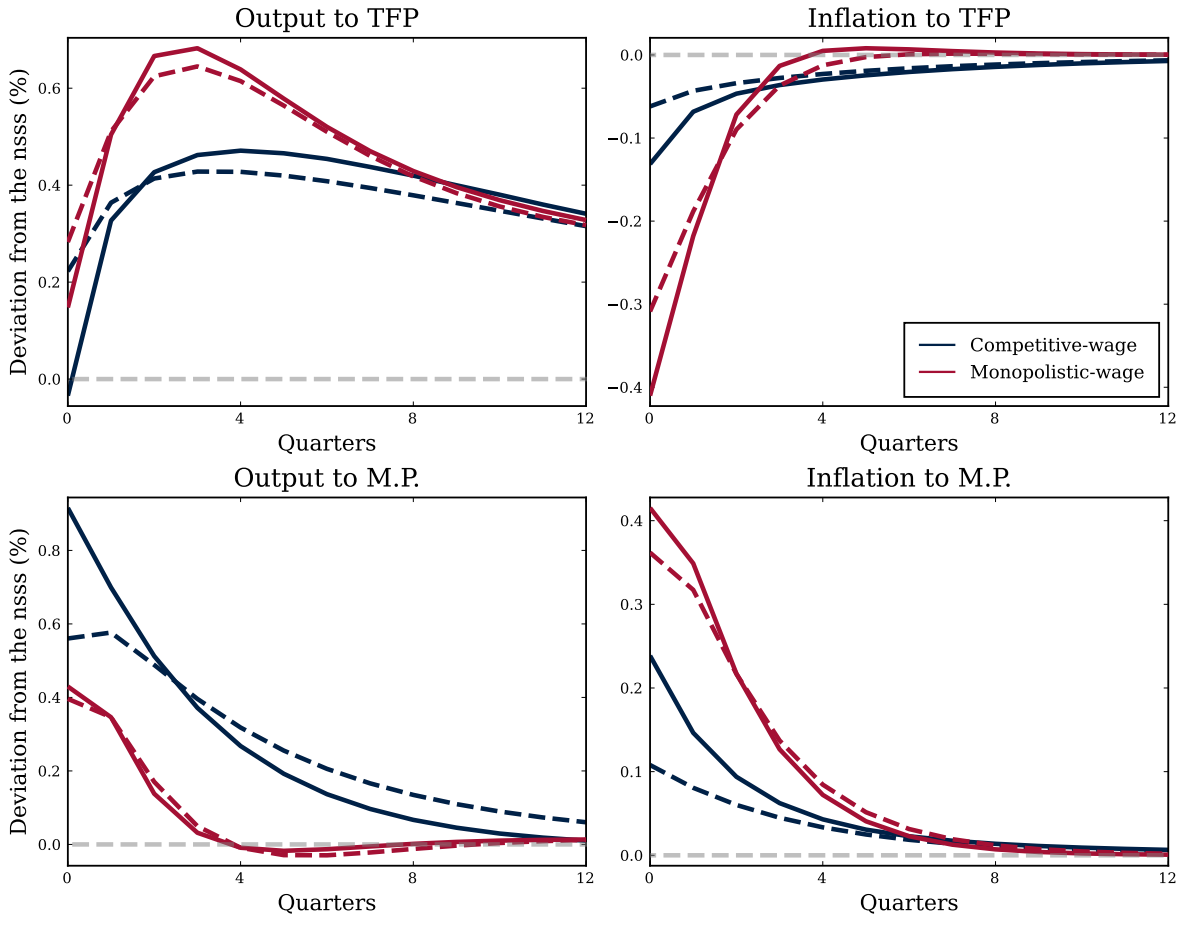


Relevance of Heterogeneity

		RI-I		RI-II	
	Data	TA	RA	TA	RA
ρ_{π}	0.62	0.62	0.75	0.62	0.69
$\rho_{\Delta y}$	**0.3**	**-0.06**	**0.19**	**0.3**	**0.34**
$\rho_{\Delta w}$	0.48	-0.20	-0.12	0.63	0.59
$\sigma_{\pi}/\sigma_{\Delta y}$	1.06	0.33	0.29	1.15	1.10
$\sigma_{\Delta w}/\sigma_{\Delta y}$	1.10	3.72	4.05	0.80	0.85

Notes: TA for two-agent models. RA for Ricardian models.

Relevance of Heterogeneity



Notes: Solid lines (—) TA models. Dashed lines (– – –) Ricardian models.

Takeaways

Neither baseline can match both micro *and* macro moments.

- **Competitive wage**,
  - Labor income (and HtM consumption) peaked on impact.
  - Consumption-saving lead to more accurate forecasts for $h = \mathcal{S}$.
- **Monopolistic wages**
  - Labor income (and HtM consumption) hump shaped.
  - Attention largely skewed toward intratemporal decision.

Ways Out of the Conundrum

How to simultaneously match micro and macro moments?

- Losses incurred from intratemporal decisions must not exceed those from intertemporal decisions by an order of magnitude.
- Inattention (or other adjustment fricions) must induce inertia in wages (and labor income).

Compatible microfoundations,

- Wages set by unions.
- Market power on the side of firms (monopsony).

Conclusions

Conclusions: Part I

Previous work,

- RI helps to bridge the gap between benchmark (Ricardian) macro models and the data (e.g., induce inertial responses to shocks).
- Small attention costs imply realistic degree of information rigidity.

This paper,

- RI does not naturally induce persistence in macro variables *and* cross-sectional expectations that match the data.
- Baseline models have different conclusions regarding the relevance of heterogeneity (policy experiments).
- To resolve the conundrum, amendments must be made to the microfoundations.

Conclusions: Part II

- Suggest caution when it comes to "ad-hoc" departures from FIRE (Lucas critique),
  - Auclert, Rognlie, and Straub (2020),
  - Moll (2024).
- The model may approximate full HA dynamics if
  - The share of HtM households, ϕ, is stable to aggregate shocks.
  - HtM status is persistent at the individual level.

  but neglects the precautionary savings and countercyclical risk channels, potentially important for attention allocation.

Descriptive Statistics

	Negative Income Shock	Liquidity Constraint	Default Probability
ϕ (HtM share)	0.47	0.24	0.04
Median liquid assets			
Hand-to-mouth	3,450	-4,500	-20,000
Savers	10,500	15,000	8,000
Inflation forecast errors			
Median ratio	0.83	0.57	0.65
S.D. ratio	0.88	0.74	0.79
Interest rate forecast errors			
Median ratio	0.95	0.85	0.97
S.D. ratio	0.98	0.97	1.03

Notes: Liquid assets as the current value of savings accounts (excluding retirement accounts) minus outstanding debt (excluding housing). Forecast errors measured in absolute values. Ratios savers over HtM.

Back to presentation.

Equilibrium: Numerial Procedure

Guess and Verify:

0. Guess stoch. processes for the aggregate laws of motion.
1. Obtain a low order VARMA representation for the attention problems' state vectors.
2. Solve the attention problems.
3. Aggregate individual actions.
4. Compare the resulting laws of motions with their initial guesses.
5. Update guesses, and repeat until convergence.

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Calibration of Heterogeneity Parameters

Estimating the Share of HtM

- Compute net liquid wealth.
- Obtain credit limit.
- Using Kaplan, Violante, and Weidner (2014)'s estimator identify households at their credit limit or with 0 net liquid wealth.

Estimating the Consumption Ratio

- Compute total gross income.
- Apply the tax rate.
- Compute savings required to maintain constant net liquid wealth at some inflation rate.
- Infer consumption from the difference between after-tax income and savings.
- Take the median across both types.

ϕ and $\frac{C^{\mathcal{S}}}{C^{\mathcal{H}}}$ are set to their average over the sample.

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Losses from Suboptimal Actions

RI-I: Competitive Labor Market.

* $\boldsymbol{\Theta}_j^{\mathcal{H}} = -1.14\,[1.94]$
* $\boldsymbol{\Theta}_j^{\mathcal{S}} = -0.96 \begin{bmatrix} 1.5 & 0 \\ 0 & 0.61 \end{bmatrix}$

RI-II: Households with Market Power.

* $\boldsymbol{\Theta}_j^{\mathcal{H}} = -1.14\,[34.44]$
* $\boldsymbol{\Theta}_j^{\mathcal{S}} = -0.96 \begin{bmatrix} 1.5 & 0 \\ 0 & 12.14 \end{bmatrix}$

Back to presentation.