Attention-Driven Sentiment and the Business Cycle

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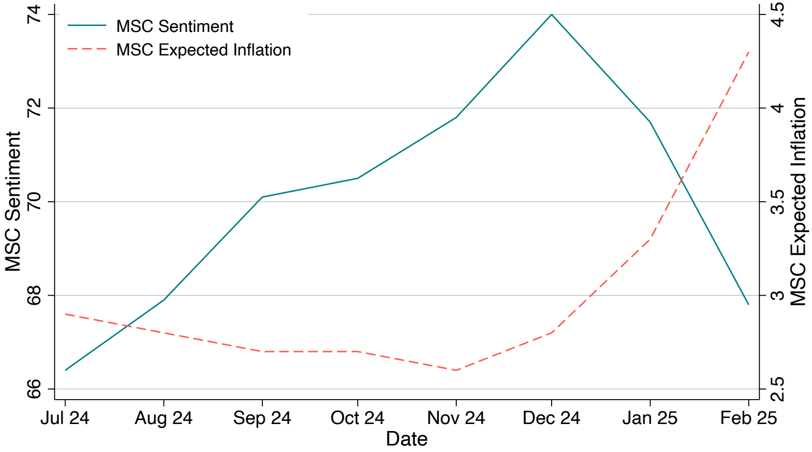
Recent Developments in Consumer Sentiment and Expectations

- Recent rise in inflation expectations and a decline in consumer sentiment



Motivation

- Part of a broader phenomena: consumers apparently use supply-side reasoning
    - Consumers associate $\uparrow$ inflation with recessionary outcomes (eg, $\uparrow$ unemployment)
    - Households often report "greed" and "big business and corporate profits" as drivers of inflation [Shiller (1997)]
    - Relative to experts, households consistently use supply-side reasoning more and demand-side reasoning less [Andre et al (2022a), Andre et al (2022b)]

Research Questions

- Why do people think this way?
- What are the implications for aggregate dynamics and policy?

Preview: Empirical Results

- Across time and demographics, consumers who believe unemployment will rise, expect higher inflation
- Furthermore, consumer beliefs are well-described by a single factor
- This factor behaves like sentiment: "optimistic" consumers forecast typical expansionary outcomes
  - Falling unemployment and improving business conditions
  - Improving personal financial conditions
  - Forward- and backward-looking beliefs
  - Interestingly, predict disinflation
- In contrast, professional forecasters'
  - Inflation and unemployment expectations are typically negatively correlated
  - Correlation between inflation and unemployment expectations varies over time
  - Beliefs have a richer factor structure

Preview: TANK Model

- We develop a two-agent New Keynesian model where rationally inattentive consumers face fundamental uncertainty about demand and supply shocks
- Optimal information-gathering economizes on information costs and compresses the dimensionality of consumer beliefs
- We derive conditions under which households relying on labor income
  - Optimally devote more attention to supply shocks
  - Thus, inflation is perceived as countercyclical

Preview: TANK Model Aggregate Dynamics and Implications

Dynamics

- As is typical in TANK models, the existence of hand-to-mouth agents implies aggregate consumption reacts more strongly to demand shocks than in RANK
- In our model, as common with rational inattention, the decisions of information-constrained agents underreact relative to full-information
- However, when inattentive hand-to-mouth agents make active decisions about labor supply, consumption can overreact to demand shocks $\implies$ additional amplification

Policy Implications

- Policy that aims to stimulate output by raising inflation expectations may backfire
- The conditions under which this policy fails are closely related to conditions under which households overweight supply factors

Survey Data

Michigan Survey of Consumers (MSC)

- Monthly, consumer survey of $\approx$ 500 (1978-present)
- Rotating panel (up to 2x)
- Example questions
  - Unemployment: “How about people out of work during the coming 12 months – do you think that there will be more unemployment than now, about the same, or less?”
  - Inflation: “By about what percent do you expect prices to go (up/down) on average, during the next 12 months?”
  - Most questions are categorical
- Results are similar using the NY Fed Survey of Consumer Expectations

Survey of Professional Forecasters (SPF)

- Quarterly, professional survey of $\approx$ 40 (1968-present)
- Rotating panel

Consumers: Unemployment and Inflation

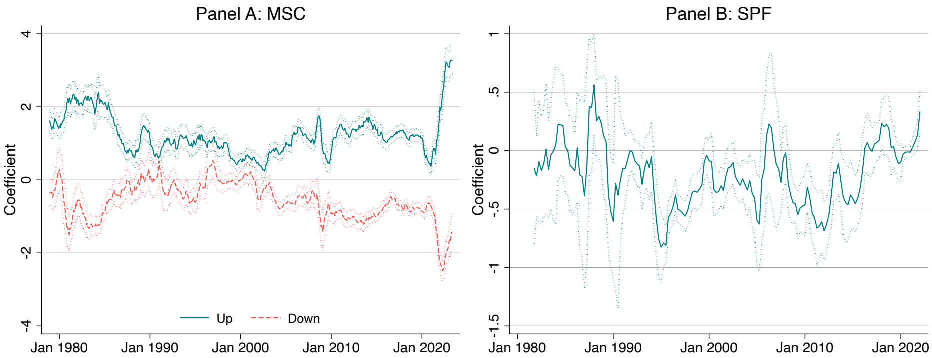
- Consumers associate higher unemployment with higher inflation (and vice versa)

$$\hat{\pi}^{1Y}_{j,t} = \beta^{+}\hat{u}^{+}_{j,t} + \beta^{-}\hat{u}^{-}_{j,t} + \boldsymbol{\gamma}\mathbf{X}_{j,t} + \varepsilon_{j,t}$$

	(1)	(2)
Unemployment Up	1.321***	0.383***
	(0.026)	(0.038)
Unemployment Down	-0.714***	-0.312***
	(0.027)	(0.039)
Respondent FEs	N	Y
Time FEs	Y	Y
R-sq	0.125	0.681
Obs.	281,034	194,614

Consumers vs Professionals: Rolling Regressions

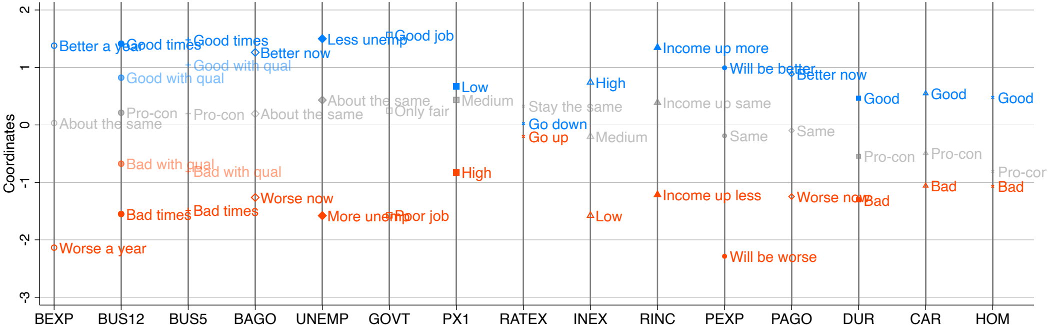
- **Consumers:** consistent positive correlation in inflation and unemployment beliefs
- **Professionals:** typically negative correlation in inflation and unemployment beliefs



Notes: Each regression includes time fixed effects but no individual fixed effects. For Panel B, we take a 1-year forecast horizon and include SPF forecasts of unemployment in levels. Dotted lines represent 90% confidence intervals.

Consumers: MCA Estimated Loadings of First Component

- Baseline MCA: include all questions asked continuously since 1980
- Responses associated with more traditionally “optimistic” outlooks have high and positive loadings (blue); and “pessimistic” responses have negative loadings (red)



Consumers: One-Factor Belief Structure

- The first component in the baseline explains over 80% of the variation
- Regardless of questions included, the first component explains a majority of the variation and fitted first components are highly correlated with that of the baseline

	Baseline	Additional Prices		Aggregate Only		Personal Only
	(1)	(2)	(3)	(4)	(5)	(6)
Dim 1 %	81.9	82.7	82.5	89.3	88.2	66.9
Dim 2 %	4.9	4.7	4.9	3.1	3.1	13.6
Base Corr.		0.998	0.991	0.928	0.931	0.768
Obs.	199,438	125,881	56,166	237,636	139,476	243,752
Start Date	1978	1990	2007	1978	1990	1978

Notes: MCA results for various questions: (1) baseline; (2) adds 5-year gas questions (introduced in 1990); (3) adds home price questions (introduced in 2007); (4) aggregate questions only; (5) aggregate only, including gas price questions; (6) personal questions only.

Consumers: Similar Belief Structures Across Demographics

- Estimating the MCA on demographic subgroups yields similar results in terms of (i) fraction explained and (ii) the correlation with our baseline MCA

	Income		Home Value		Investment		Education	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dim 1 %	80.5	80.9	85.4	82.1	82.7	81.1	82.2	81.1
Dim 2 %	5.8	5.0	4.4	4.9	4.2	5.0	5.1	5.2
Base Corr.	0.999	0.999	0.998	0.999	0.999	0.998	0.999	0.999
Obs.	23,024	48,307	10,672	14,327	11,431	14,902	52,749	47,759
Start Date	1979	1979	1990	1990	1990	1990	1978	1978

Notes: MCA results using the baseline set of questions across different respondent subgroups: bottom/top quintiles of income groups (1 and 2); bottom/top quintiles of home value (3 and 4); bottom/top quintiles of stock holdings (5 and 6); and no college/college degree (7 and 8).

- Note: professionals have a richer factor structure to their beliefs

Model: Setting

- Firms: differentiated firms face pricing frictions and produce using labor
- Households: some have access to financial markets (“savers”); others do not and consume all income each period (“hand-to-mouth”) (Bilbiie, 2020)
- Innovation: add rational inattention to hand-to-mouth households (Sims, 2003)
- Shocks: aggregate discount rate (“demand”) and labor disutility shock (“supply”)

Questions:

- When do information-constrained agents form beliefs consistent with empirics?
- Explore the aggregate implications of belief frictions

Households: Savers

- Saver households, $j \in (\lambda, 1]$, are denoted with "S"
- They maximize lifetime discounted expected utility:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u\left(C_t^S, N_t^S; \mathbf{Z}_t\right)$$

subject to:

$$C_t^S + Q_t B_t^S = B_{t-1}^S + W_t N_t^S + T_t^S$$

- **Standard:** FIRE; choose consumption, labor, saving to max lifetime expected utility
- Note $\mathbf{Z}_t$ contains aggregate shocks (discount factor Ψ_t and labor disutility Γ_t)

$$u(C_t^j, N_t^j; \mathbf{Z}_t) = \Psi_t \left[\frac{\left(C_t^j\right)^{1-\varsigma} - 1}{1-\varsigma} - \Gamma_t \frac{\left(N_t^j\right)^{1+\varphi}}{1+\varphi} \right]$$

Model: Firms

- Firms maximize discounted expected profits:

$$\mathbb{E}_t \sum_{k=0}^{\infty} \theta^k Q^S_{t,t+k} \left[\left(1+\tau^S\right) \left(P_t(i)/P_{t+k}\right) Y_{t+k}(i) - W_{t+k} N_{t+k}(i) - T^F_{t+k} \right]$$

- subject to:
  - **Production function:** $Y_t(i) = N_t(i)$
  - **CES Demand:** $C_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\epsilon} C_t$
- **Standard:** Calvo, CES demand, monopolistically competitive firms, production subsidy
- **Non-standard:** Firms are owned by S households $\Rightarrow$ SDF is of S households and expectations are taken under FIRE

Model: Government

- Fiscal authority sets optimal production subsidy $\Rightarrow$ markups are zero in steady state
- The production subsidy is financed by lump-sum taxes on firms
- Profits paid to S households are taxed (τ^D) and redistributed to H households
- Central bank sets the nominal rate i_t

Households: Hand-to-Mouth

- Hand-to-mouth households, $j \in [0, \lambda]$, are denoted with "H"
- H households cannot borrow or save
- Face information constraints and do not observe current or past variables perfectly
- Collect noisy signals $\mathbf{s}_t^j$ (more precise signals are more costly); expectations are formed with respect to the information set (the history of signals)

$$\left\{\mathbf{s}_\tau^j\right\}_{\tau \leq t} \equiv \mathcal{I}_t^j$$

- Denote the expectation operator of household j as $E_t^j \neq \mathbb{E}_t$

Households: Hand-to-Mouth Maximization

- Budget constraint:

$$C_t^{H,j} = W_t N_t^{H,j} + T_t^H$$

- How can this bind?
  - We assume there is a head of household that collects information, tells the worker how much to work, then the shopper takes the wage income and consumes
  - Labor is the active choice and consumption is the residual
- H households maximize:

$$E_t^j\, U\left(N_t^{H,j}; \mathbf{X}_t\right) - \mu I\left(\mathbf{X}_t; \mathcal{I}_t^j \middle| \mathcal{I}_{t-1}^j\right)$$

  by choosing the distribution of signals $\mathbf{s}_t^j$ and labor supply $N_t^{H,j}$, taking $\mathcal{I}_{t-1}^j$ as given
- $\mathbf{X}_t$ contains $\mathbf{Z}_t$ and anything affecting W_t and T_t^H
- H households are myopic ($\beta = 0$ consistent with Aguiar et al 2024)

Model: Aggregation, Linearization, Optimality

- Average consumption and labor supply of the H households:

$$C_t^H \equiv \frac{1}{\lambda}\int_0^{\lambda} C_t^{H,j}\,\mathrm{d}j \text{ and } N_t^H \equiv \frac{1}{\lambda}\int_0^{\lambda} N_t^{H,j}\,\mathrm{d}j$$

- Aggregate consumption and labor supply (log-linearized around symmetric ss):

$$y_t = \lambda c_t^H + (1-\lambda)c_t^S \text{ and } n_t = \lambda n_t^H + (1-\lambda)n_t^S$$

- Saver household optimality conditions:

$$w_t = \gamma_t + \varsigma c_t^S + \varphi n_t^S \text{ and } \mathbb{E}_t \Delta c_{t+1}^S = \varsigma^{-1}\left(i_t - \mathbb{E}_t \pi_{t+1} - v_t\right)$$

  - $\gamma_t = \log \Gamma_t$ is the aggregate labor disutility shock
  - $v_t = -\mathbb{E}_t \Delta \psi_{t+1} = -\mathbb{E}_t \Delta \log \Psi_{t+1}$ is the aggregate discount factor shock

- New Keynesian Phillips curve:

$$\pi_t = \kappa_w w_t + \beta \mathbb{E}_t \pi_{t+1}$$

- Profits (linearized) $= -w_t$

Model: FIRE Benchmark

- Under full information (like in Bilbiie, 2020):

$$(\varsigma + \varphi) n_t^{H*} = \chi_n w_t - \gamma_t \quad \text{and} \quad (\varsigma + \varphi) c_t^{H*} = \chi_c w_t - \gamma_t$$
$$\text{where} \quad \chi_n \equiv 1 - \varsigma \left(1 - \tau^D / \lambda\right) \quad \text{and} \quad \chi_c \equiv 1 + \varphi \left(1 - \tau^D / \lambda\right)$$

- Optimal labor choice responds to the wage (w_t)
  - χ_n is proportional to the elasticity of labor supply to the wage
  - χ_n is a function of preferences (ς), transfers (τ^D), and share of H households (λ)
- Optimal labor choice also responds to the labor disutility shock (γ_t)
- With information frictions, H households are unable to pick n_t^{H*} perfectly
  - Nor will the average across H households be the FIRE benchmark

Model: Equilibrium

- Aggregate H labor supply is:

$$n_t^H = \frac{K}{\varsigma + \varphi}(\chi_n w_t - \gamma_t) + (1-K)m_t \quad \text{where} \quad m_t \equiv \frac{1}{\lambda}\int_0^\lambda \tilde{n}_t^{H,*,j}\,\mathrm{d}j$$

- Aggregate priors, m_t, is a state variable
- The optimal signal will put nonzero weight on $m_t \implies$ "infinite regress" and AR(∞) aggregate dynamics
- We have some general results about beliefs and dynamics in the paper
- One takeaway: H households will have a single factor belief structure
  - H households make one choice $\implies$ at most one signal

IID Case: Output and Inflation

- To develop intuition, the iid case is helpful:

$$v_t = \epsilon_{v,t} \text{ and } \gamma_t = \epsilon_{\gamma,t} \text{ where } \varepsilon_{v,t} \sim N\left(0, \sigma_v^2\right) \text{ and } \varepsilon_{\gamma,t} \sim N\left(0, \sigma_\gamma^2\right)$$

- Priors are at steady state, so aggregate labor choice:

$$n_t^H = K n_t^{H,*}$$

- Simple Taylor rule $i_t = \phi_\pi \pi_t$
- In equilibrium, y_t and π_t are functions of current discount and labor disutility shocks:

$$y_t = C_{y,v} v_t + C_{y,\gamma} \gamma_t, \quad \pi_t = C_{\pi,v} v_t + C_{\pi,\gamma} \gamma_t$$

- **Assumption:** Parameters are such that $C_{y,v} > 0, C_{\pi,v} > 0, C_{y,\gamma} < 0, C_{\pi,\gamma} > 0$
  - The discount factor shock v_t acts like a demand shock
  - The labor disutility shock γ_t acts like a supply shock
  - Why do we need this? High info costs $\implies$ H labor barely reacts and consumption could rise in response to a supply shock $\implies$ output rises $C_{y,\gamma} > 0$

Correlations: Physical and Beliefs

- Under what conditions do posterior beliefs feature negative correlation between output and inflation, while (unconditional) correlations are positive?
- The unconditional correlation of output and inflation is positive iff:

$$C_{y,v}C_{\pi,v}\sigma_v^2 + C_{y,\gamma}C_{\pi,\gamma}\sigma_\gamma^2 > 0$$

- Belief correlations depend crucially on $\chi_n = 1 - \varsigma\left(1 - \tau^D/\lambda\right)$, which governs the elasticity of H labor supply to the real wage
- If $\chi_n = 0$, (either log-utility with no-transfers or $\varsigma \neq 1$ with offsetting transfers)
  - Optimal labor choice is independent of the real wage due to offsetting income and substitution effects
  - Optimal labor choice is only a function of supply shocks, and so H households choose to only learn about supply shocks (regardless of their volatility)
  - Posterior beliefs inherit the properties of the model conditional on supply shocks

Correlations: Physical and Beliefs

- If $\chi_n \neq 0$, posterior beliefs of output and inflation can be negatively or positively correlated (exact conditions are in the paper)
- Intuition if volatility of supply shocks is very small:
  - The optimal signal will place weight on the real wage which will be largely driven by demand rather than supply shocks
  - Posterior beliefs will inherit the conditional response of the model to demand shocks, resulting in a positive correlation in beliefs

Dynamics: First Derivatives and Intuition

- In the limit of no H agents ($\lambda \to 0$) and no information costs ($K \to 1$), conditional responses wrt the fraction of hand-to-mouth (λ) are:

$$\frac{\partial C_{y,v}}{\partial \lambda} \to \frac{\varphi(1-\chi_n)}{(\varsigma + (\varsigma+\varphi)\kappa_w \phi_\pi)^2}, \quad \frac{\partial C_{y,\gamma}}{\partial \lambda} \to \frac{\varsigma\varphi(1-\chi_n)}{(\varsigma+\varphi)(\varsigma + (\varsigma+\varphi)\kappa_w \phi_\pi)^2}$$

- Amplification of the output response to demand shocks (if $\chi_n \leq 1$)
  - A demand shock ↑ desired S consumption; output and wages ↑ in the RANK benchmark
  - A wage increase (all else equal) induces a larger positive consumption response of H households relative to S households
- Mitigation of the output response to supply shocks (if $\chi_n \leq 1$)
  - A supply shock ↓ output, but wages ↑ in the RANK benchmark
  - A wage increase (all else equal) puts more upward pressure on H consumption relative to S consumption

Dynamics: Second Derivatives and Intuition

- In the limit of no H agents ($\lambda \to 0$) and no information costs ($K \to 1$), conditional responses wrt the fraction of hand-to-mouth (λ) and information costs ($-K$) are:

$$-\frac{\partial^2 C_{y,v}}{\partial\lambda\partial K} \to \frac{-\chi_n}{\varsigma + (\varsigma+\varphi)\kappa_w\phi_\pi}, \qquad -\frac{\partial^2 C_{y,\gamma}}{\partial\lambda\partial K} \to \frac{\varsigma(1-\chi_n) + (\varsigma+\varphi)\kappa_w\phi_\pi}{(\varsigma+\varphi)(\varsigma+(\varsigma+\varphi)\kappa_w\phi_\pi)}$$

  - In response to a **demand shock**, in the FIRE-RANK limit, output and wage $\uparrow$
    - If $\chi_n < 0$, H households will want to $\downarrow$ labor, due to info costs will not reduce labor as much as FIRE $\Longrightarrow$ TANK amplifies demand shocks, and info costs add further amplification
    - If $0 \leq \chi_n \leq 1$, H households will want to $\uparrow$ labor, due to info costs will not increase labor as much as FIRE $\Longrightarrow$ TANK amplifies demand shocks, but info costs weaken it
  - In response to a **supply shock**, if ϕ_π large regardless of χ_n, wages will not move much and H choices will be driven by γ_t. H households will $\downarrow$ labor, but due to info costs by less than under FIRE $\Longrightarrow$ info costs dampen the reaction to supply shocks (more mitigation or less amplification relative to TANK)

Expectation Manipulation Policy

- Following the Great Recession with rates at the zero lower bound, there were discussions of using "inflation expectations as a policy tool": trying to increase inflation expectations to stimulate the economy
- Suppose the policymaker could manipulate the signals received by households:

$$s_t^j = n_t^{H,*} + \alpha z_t + \eta_t^j \text{ such that } \frac{\partial E_t^j \pi_t}{\partial z_t} > 0$$

- If households overweight supply factors and have a negative correlation between inflation and output beliefs (eg. $\chi_n = 0$),

$$\implies \frac{\partial y_t}{\partial z_t} \leq 0$$

- Inflation expectation policy is contractionary

Dynamic Model

- Shocks follow AR(1) processes
- Log-utility with no transfers ($\chi_n = 0$)
- Optimal labor is therefore:

$$n_t^{H,*} = -\frac{1}{\varsigma + \varphi}\gamma_t$$

- So, average priors evolve simply:

$$m_t = \rho_\gamma(1 - K)m_{t-1} - \rho_\gamma K\frac{1}{\varsigma + \varphi}\gamma_{t-1}$$

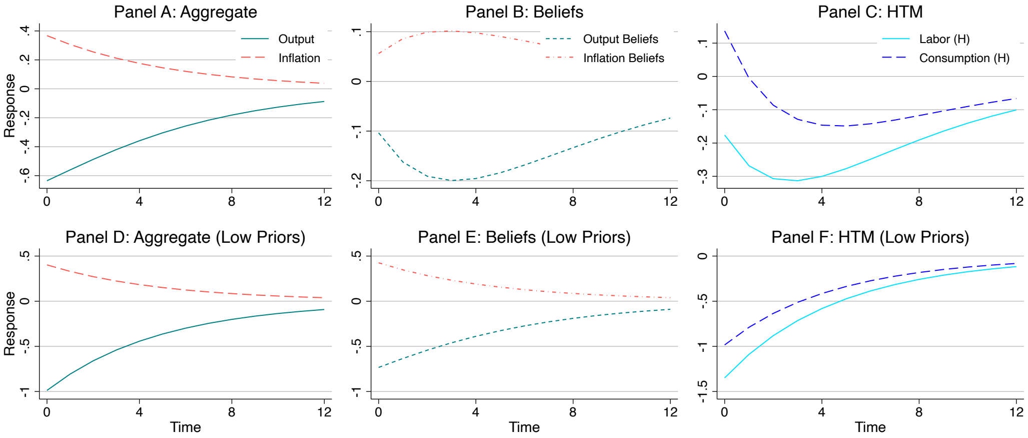
- H's optimal signal tracks an exogenous variable with known dynamics (γ_t)
  - " Infinite regress" issues arise when H households track endogenous variables (eg, wage)

Calibration

Parameter	Value	Description	Target
Panel A:			
β	0.9975	Discount Factor	Long-run rate
ς	1.0	CRRA	Log-utility, $\chi_n = 0$
$\frac{\tau^D}{\lambda}$	0.0	Transfers	Log-utility, $\chi_n = 0$
λ	0.33	Hand-to-Mouth	Fraction 1/3
ϕ_π	1.5	Taylor Rule	Inflation Coeff.
ϕ_y	0.1	Taylor Rule	Output Coeff.
Panel B:			
φ	0.5301	$\sigma\left(w_t\right)$	1.5682
κ_w	0.198	$\rho\left(y_t, \pi_t\right)$	0.0689
ρ_v	0.7133	$\rho\left(y_t, y_{t-1}\right)$	0.8074
ρ_γ	0.8239	$\rho\left(\pi_t, \pi_{t-1}\right)$	0.749
σ_v	0.7613	$\sigma\left(y_t\right)$	1.5757
σ_γ	1.7843	$\sigma\left(\pi_t\right)$	1.2007
K	0.151	$\rho\left(\hat{\pi}_t^j, \pi_t\right)$	0.332

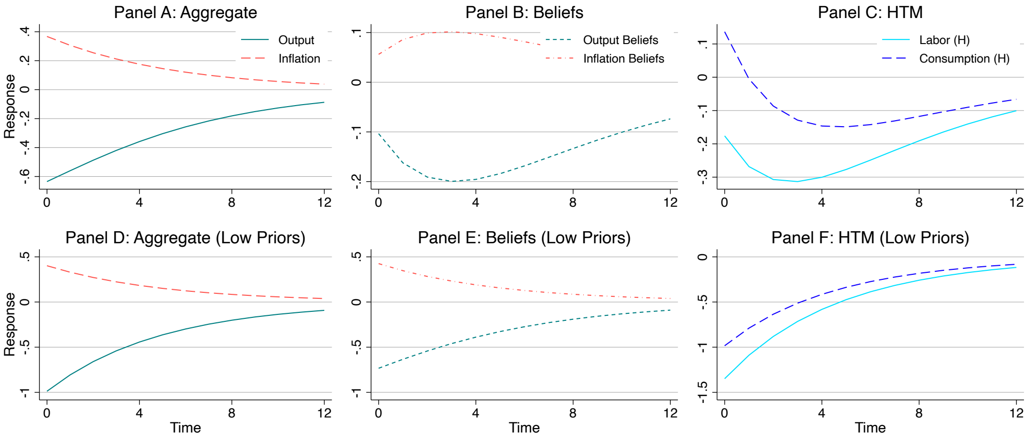
Response: Supply Shock

- In response to a supply shock, inflation rises and output falls
- H households learn about supply, their inflation beliefs rise and output beliefs fall
- H labor supply falls, but less than in FIRE, and consumption rises



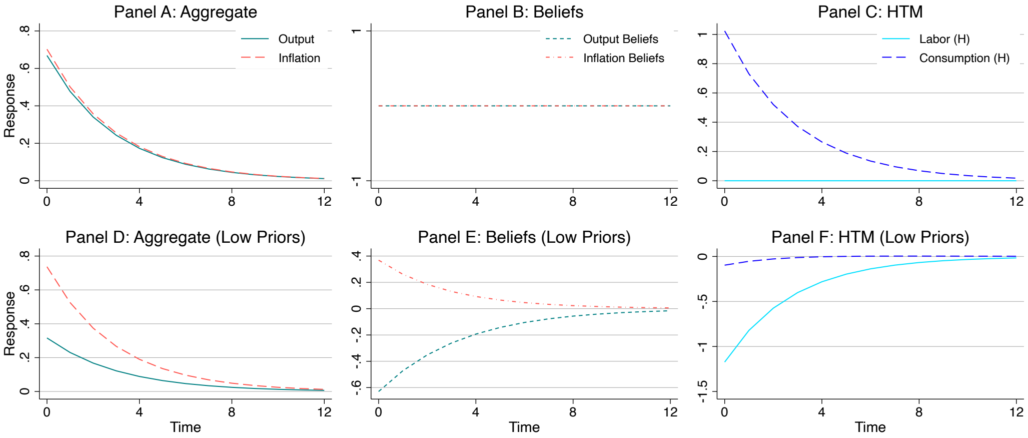
Response: Supply Shock

- If priors are low (households ex-ante think a supply-driven recession is likely)
- Then the decline of output is larger, driven by a larger decline in labor



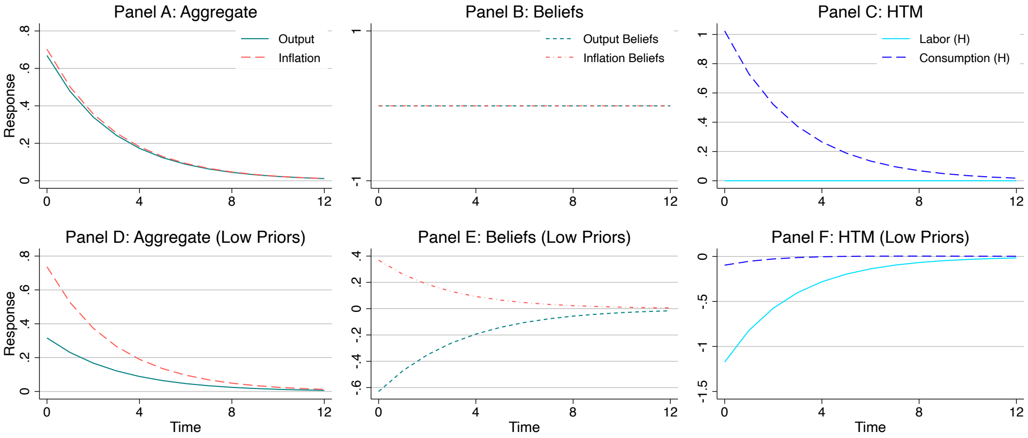
Response: Demand Shock

- In response to a demand shock, inflation and output rise
- H households do not learn about demand and their beliefs are unaffected
- H labor supply is unaffected, but consumption rises



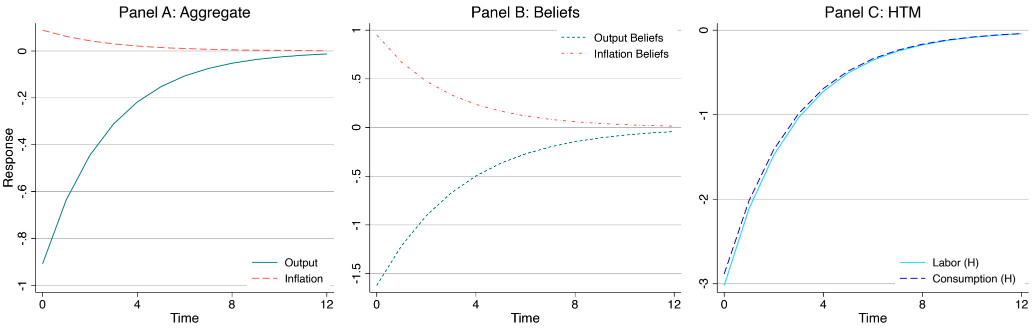
Response: Demand Shock

- If priors are low (ex-ante supply-driven recession likely)
- H beliefs reflect this and their labor supply is lower relative to steady state
- Output rises, but not as much as with steady state priors



Response: Expectation Manipulation Policy

- Suppose the policymaker manipulates the average signal received by H households so that inflation beliefs rise
- H households will expect a supply-driven recession (inflation beliefs rise, output beliefs fall), and will reduce labor supply $\implies$ output falls



Conclusion

- Using survey data
  - Consumers' expectations exhibit a low-factor structure...
  - ...and believe inflation is countercyclical
- In a TANK model featuring RI
  - Agents economize information costs and obtain a single signal (single factor belief model)
  - This strategy typically implies higher precision in beliefs about supply-driven recessions and less about demand-driven recessions (countercyclical inflation beliefs)
- Implications
  - Aggregate dynamics are affected by the evolution of beliefs
  - Policies that increase inflation expectations to stimulate the economy may backfire