Inferring the Aggregate

Information Frictions and Macroeconomic Dynamics

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Introduction

- Expectations crucial for Macroeconomics, empirical work documents two facts:
  1. Expectations about aggregates (unemployment, output, etc.) are heterogeneous
  2. These expectations respond strongly to idiosyncratic shocks
- This project brings this into heterogeneous agent, general equilibrium models
- Dispersed information instead of full information rational expectations (FIRE)
- Question: How does this matter for macroeconomic dynamics?

Main Contribution

- **Bayesian learning about endogenous aggregate variables**
- Bring into rational expectations model with occasionally binding constraints
- Framework with **heterogeneous agents** (HA) in **general equilibrium** (GE)
- Assumption: Agents observe all objects directly in their budget, not aggregates
    - Literature on information frictions, but unsolved question in such models Details
- To solve, **develop solution method** based on Krusell and Smith (1998)

Results & Preview

- Implemented in a Small open economy model:
- **MPCs have an information component**
    - Any change in resources may also provide information
- **Response to productivity shocks changes with the friction**
    - Consumption response becomes more sluggish
- **Outline:** One slide on literature, after that model & results

Literature, empirics

- Personal experiences/shocks influence expectations about aggregates:
  - **Grocery prices & other experiences affect inflation expectations:** Cavallo et al. (2017), D'Acunto et al. (2021), Weber et al. (2022) ...
  - **Similarly, own vs aggregate unemployment, house prices, or income:** Kuchler and Zafar (2019), Adams and Rojas (2024), Taubinsky et al. (2024)
- Part of this paper: Add to this literature from SCE data
  - Findings: individual finances affect expectations about aggregate unemployment

Small Open Economy Model

Households

- Unit mass of households $i \in [0,1]$, constant $R < 1/\beta$
- Preferences:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_{it}^{1-\sigma}}{1-\sigma} - \frac{\chi}{1+\varphi} H_{it}^{1+\varphi} \right]$$

- Budget constraint with foreign bond B_{it}:

$$C_{it} + B_{i,t+1} = RB_{it} + \underbrace{W_{it}}_{W_t E_{it}} H_{it}, \quad B_{i,t+1} \geq 0$$

- Where idiosyncratic efficiency $e_{it} \equiv \log E_{it} \sim \mathcal{N}\left(-\frac{\sigma_e^2}{2}, \sigma_e^2\right)$

Production

- Technology:

$$Y_t = Z_t N_t^{1-\alpha}$$

- Aggregate productivity:

$$z_{t+1} = \rho z_t + \mu_{t+1}, \qquad \mu_{t+1} \sim \mathcal{N}(0, \sigma_\mu^2)$$

- Competitive wage per efficiency unit:

$$W_t = (1-\alpha) Z_t N_t^{-\alpha}$$

- Profits $\Pi_t = \alpha Z_t N_t^{1-\alpha}$ are rebated to foreign firm owners

Information Friction

- Expectation about w_{it+1} pinned down by expectations over w_{t+1}, or (z_{t+1}, n_{t+1})
- Households observe only signals:

$$s_{it} \equiv w_{it} + \frac{\sigma_e^2}{2} = w_t + \varepsilon_{it}, \qquad \varepsilon_{it} \equiv e_{it} + \frac{\sigma_e^2}{2} \sim \mathcal{N}(0, \sigma_e^2)$$

- Wages are an equilibrium object:

$$W_t = (1-\alpha) Z_t N_t^{-\alpha}, \qquad N_t = \int_i E_{it} H_{it}\, di,$$

- Consider transitory shock e_{it}, cannot fully separate from a shock to Z
    - This increases the "MPC", higher expected future earnings!

Towards a solution

- Let $S_t = (z_t, \Gamma_t)$, where Γ_t is the distribution over individual states
- Households must form beliefs about the aggregate state S_t
- Let $s_i^t \equiv \{s_{i\tau}\}_{\tau=0}^t$. Individual state expands to include information:

$$(B_{it}, w_{it}, s_i^t)$$

- Heterogeneous agent (HA), general equilibrium (GE) model with aggregate risk
- Solving for Γ_t in such models is not trivial, even with full information

Numerical challenges

- To solve the model, have to:
  1. Even without information friction, forecast wages (recall: infinite-dimensional Γ_{t+1})
  2. With the friction, need to run signal extraction problem in parallel
- But now, how Γ_{t+1} evolves is affected by information extraction, and vice versa
- Note: Households only care about S insofar as it affects

$$w_t = \log(1-\alpha) + \log z_t - \alpha n_t$$

Full Bayesian updating, current aggregates

- Suppose households start period t with a normal prior:

$$w_t \mid s_i^{t-1} \sim \mathcal{N}(\hat{w}_{i,t|t-1}, P_{t|t-1})$$

- With this, can learn a lot about current wage, recall:

$$s_{it} = w_t + \varepsilon_{it}$$

- MSE are minimized by Kalman update:

$$\hat{w}_{i,t|t} = \hat{w}_{i,t|t-1} + K_t\big(s_{it} - \hat{w}_{i,t|t-1}\big), \qquad K_t = \frac{P_{t|t-1}}{P_{t|t-1} + \sigma_e^2}$$

- Subscript notation here: $\hat{w}_{i,t|t-1}$ denotes agent i's time $t-1$ expectation about w_t

Full Bayesian updating, forecasts

- The difficulty is the forecast step:

$$\hat{w}_{i,t+1|t} = \mathbb{E}\left[w_{t+1} \mid s_i^t\right] = \mathbb{E}\left[\log z_{t+1} - \alpha n_{t+1} \mid s_i^t\right] + \log(1-\alpha)$$

- n_{t+1} depends on the infinite-dimensional distribution
- Challenges: 1. Infinite-dimensional Γ_{t+1} & 2. Run signal extraction problem
- "Modern" solutions to 1. are perfect foresight perturbations around a steady state
- Extension of Krusell and Smith (1998) resolves both at once!

Krusell-Smith with signal extraction

- Approximate expectation formation by a low-dimensional perceived law of motion:

$$w_t = a_0 + a_1 w_{t-1} + a_2 \mu_t, \qquad \mu_t \sim \mathcal{N}(0, \sigma_\mu^2)$$

- This resolves both issues:
  - replaces the infinite-dimensional Γ by small forecasting object
  - Linear-Gaussian system, households can run a Kalman filter also for forecasts
- Coefficients a_0, a_1, a_2 are known to households, but w, μ not observed
- Recall: Approximating rational expectations, households understand the model
- Law of motion has to be accurate!

Krusell-Smith with signal extraction, cont'd

- Kalman update and forecast:

$$\hat{w}_{i,t|t} = (1 - K_t)\hat{w}_{i,t|t-1} + K_t s_{it}, \qquad K_t = \frac{P_{t|t-1}}{P_{t|t-1} + \sigma_e^2}$$

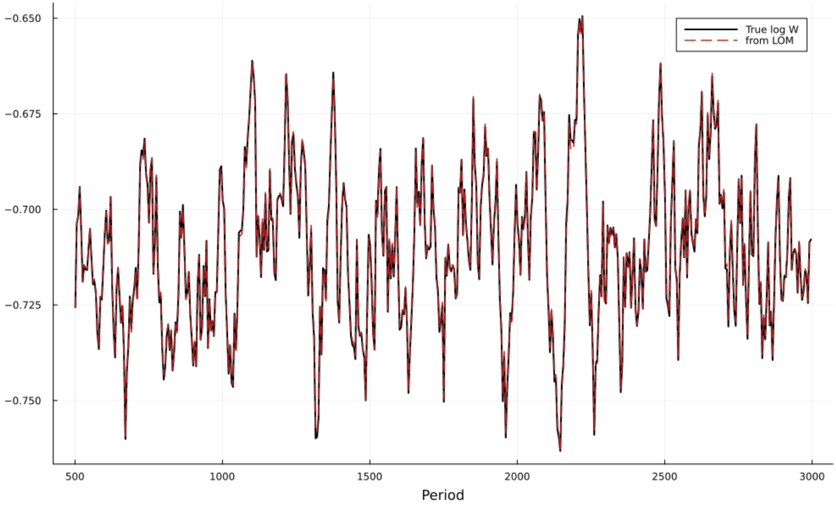
- Then get forecasts, $\hat{w}_{i,t+1|t} = a_0 + a_1 \hat{w}_{i,t|t}$, so:

$$w_{t+1} \mid s_i^t \sim \mathcal{N}(\hat{w}_{i,t+1|t}, P_{t+1|t})$$

- Now cleanly have an expectations state variable $\hat{w}_{it+1|t}$, and can solve:
- Guess $(a_0, a_1, a_2) \rightarrow$ get policies $\rightarrow$ simulate $\rightarrow$ update (a_0, a_1, a_2)
  - In practice not necessary, but if rule inaccurate add more lags $w_{t-2}, w_{t-3}, \ldots$

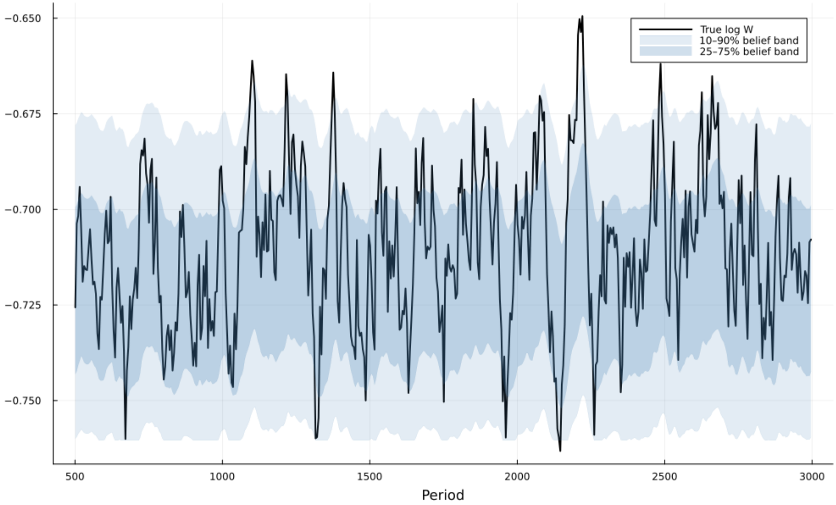
Quantitative Results

Law of motion accuracy



Details

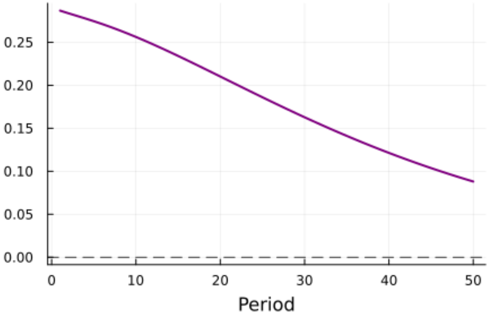
Expectation Results



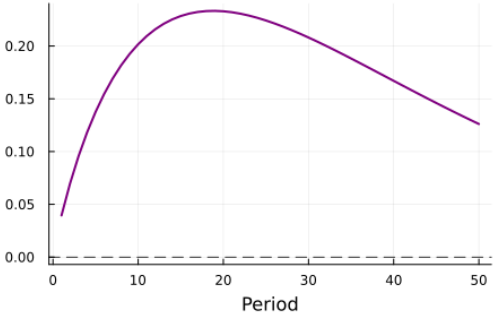
Impulse Response, full versus dispersed information

- Consumption response to a σ_μ productivity shock, compare FI, DI Details

(a) Full information



(b) Dispersed information



- **Related: Literature on excess smoothness, sluggish adjustments**
  - Campbell and Deaton (1989), Dynan (2000), Carroll (2003), Auclert et al. (2023)

More results, MPC information

Conclusion

- empirical evidence on expectation formation into HA, GE models
- Accomplished with information friction on aggregate variables
- New solution method for this class of models with info frictions
- Information component on top of MPC, affect size of response
  - Can even affect the *sign* of the response if negative information!
- Changes shape, size of consumption response to aggregate shocks

References

Adams, J. J., & Rojas, E. (2024).**Household Consumption and Dispersed Information.** *Journal of Monetary Economics*, *147*, 103592. https://doi.org/10.1016/j.jmoneco.2024.103592

Angeletos, G.-M., & Huo, Z. (2021).**Myopia and Anchoring.** *American Economic Review*, *111*(4), 1166–1200. https://doi.org/10.1257/aer.20191436

Angeletos, G.-M., & La'O, J. (2013).**Sentiments.** *Econometrica*, *81*(2), 739–779. https://doi.org/10.3982/ECTA10008

Angeletos, G.-M., & La'O, J. (2020).**Optimal Monetary Policy with Informational Frictions.** *Journal of Political Economy*, *128*(3).

Auclert, A., Rognlie, M., & Straub, L. (2023). **Micro jumps, macro humps: Monetary policy and business cycles in an estimated hank model [R&R, American Economic Review].**

Broer, T., & Kohlhas, A. N. (2024).**Forecaster (mis-)behavior.** *The Review of Economics and Statistics*, *106*(5), 1334–1351. https://doi.org/10.1162/rest_a_01210

Campbell, J., & Deaton, A. (1989).**Why is consumption so smooth?** *The Review of Economic Studies*, *56*(3), 357–373. Retrieved April 29, 2026, from http://www.jstor.org/stable/2297552

Carroll, C. D. (2003).**Macroeconomic Expectations of Households and Professional Forecasters.** *The Quarterly Journal of Economics*, *118*(1), 269–298. https://doi.org/10.1162/00335530360535207

Carroll, C. D., Crawley, E., Slacalek, J., Tokuoka, K., & White, M. N. (2020).**Sticky expectations and consumption dynamics.** *American Economic Journal: Macroeconomics*, *12*(3), 40–76. https://doi.org/10.1257/mac.20180286

Cavallo, A., Cruces, G., & Perez-Truglia, R. (2017).**Inflation Expectations, Learning, and Supermarket Prices: Evidence from Survey Experiments.** *American Economic Journal: Macroeconomics*, *9*(3), 1–35. https://doi.org/10.1257/mac.20150147

D'Acunto, F., Malmendier, U., Ospina, J., & Weber, M. (2021).**Exposure to Grocery Prices and Inflation Expectations.** *Journal of Political Economy*, *129*(5), 1615–1639. https://doi.org/10.1086/713192

Dynan, K. E. (2000).**Habit formation in consumer preferences: Evidence from panel data.** *The American Economic Review*, *90*(3), 391–406. Retrieved April 29, 2026, from http://www.jstor.org/stable/117335

Gabaix, X. (2020).**A behavioral new keynesian model.** *American Economic Review*, *110*(8), 2271–2327. https://doi.org/10.1257/aer.20162005

Guarda, S. (2026).**Narrow and Short Beliefs in Macroeconomics with Heterogeneous Agents.** *Working Paper*.

Kohlhas, A. N., & Walther, A. (2021).**Asymmetric Attention.** *American Economic Review*, *111*(9), 2879–2925. https://doi.org/10.1257/aer.20191432

Krusell, P., & Smith, A. A., Jr. (1998).**Income and wealth heterogeneity in the macroeconomy.** *Journal of Political Economy*, *106*(5), 867–896. https://doi.org/10.1086/250034

Kuchler, T., & Zafar, B. (2019).**Personal Experiences and Expectations about Aggregate Outcomes.** *The Journal of Finance*, *74*(5), 2491–2542. https://doi.org/10.1111/jofi.12819

Lorenzoni, G. (2009).**A Theory of Demand Shocks.** *American Economic Review*, *99*(5), 2050–2084. https://doi.org/10.1257/aer.99.5.2050

Lucas, R. E. (1972).**Expectations and the neutrality of money.** *Journal of Economic Theory*, *4*(2), 103–124. https://doi.org/10.1016/0022-0531(72)90142-1

Mankiw, N. G., & Reis, R. (2002).**Sticky Information versus Sticky Prices: A Proposal to Replace the New Keynesian Phillips Curve*.** *The Quarterly Journal of Economics*, *117*(4), 1295–1328. https://doi.org/10.1162/003355302320935034

Marcet, A., & Sargent, T. J. (1989).**Convergence of least-squares learning in environments with hidden state variables and private information.** *Journal of Political Economy*, *97*(6), 1306–1322. Retrieved April 29, 2026, from http://www.jstor.org/stable/1833240

Sims, C. (2003).**Implications of Rational Inattention.** *Journal of Monetary Economics*, *50*, 665–690. https://doi.org/10.1016/S0304-3932(03)00029-1

Taubinsky, D., Butera, L., Saccarola, M., & Lian, C. (2024, July). **Beliefs about the economy are excessively sensitive to household-level shocks: Evidence from linked survey and administrative data (NBER Working Papers No. 32664).** National Bureau of Economic Research, Inc.

Weber, M., D'Acunto, F., Gorodnichenko, Y., & Coibion, O. (2022).**The Subjective Inflation Expectations of Households and Firms: Measurement, Determinants, and Implications.** *Journal of Economic Perspectives*, *36*(3), 157–184. https://doi.org/10.1257/jep.36.3.157

Appendix

Fiscal policy, simple setup

- Add taxes & transfers to the household budget constraint

$$C_{it} + B_{i,t+1} = RB_{it} + W_{it}H_{it} + T_t - \tau_t$$

- Consider fiscal transfer with countercyclical & discretionary component

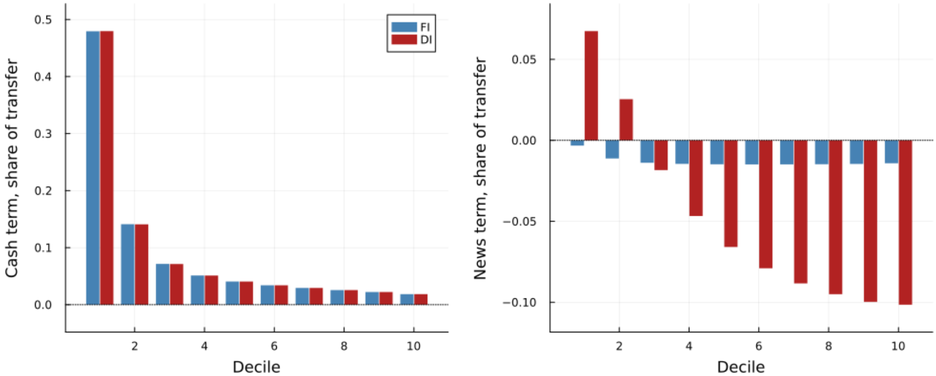
$$T_t = -\psi z_t + \nu_t, \qquad \nu_t \sim N(0, \sigma_\nu^2)$$

- Insurance for aggregate risk, but T also reveals government private information
    - Households infer from a transfer that productivity is low

Details

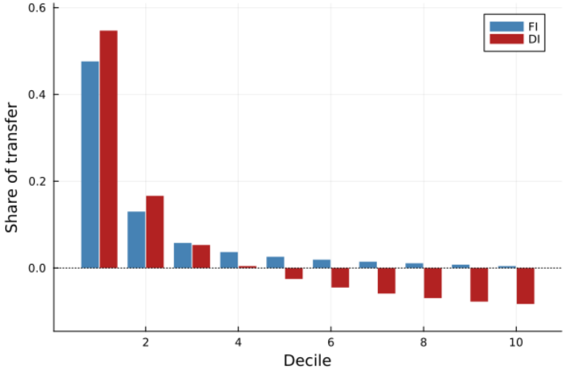
Fiscal Policy

- Can now look at MPC out of a transfer T of size ν
- Compare full information (FI) versus dispersed information (DI)



- Next, look at total response, what share of transfer is consumed?

Fiscal policy, final slide



- Model mechanism matches what I find in german BOP-HH survey data
  - RCT, informing households about stimulus: Lowers growth expectations
  - Decreases planned spending for high income households

Conclusion

Fiscal policy, detailed setup

- Countercyclical transfers with i.i.d. discretionary component:

$$T_t = -\psi z_t + \nu_t, \qquad \nu_t \sim N(0, \sigma_\nu^2)$$

- Government debt and tax rule:

$$B_{t+1}^g = (1 + r^*) B_t^g + T_t - \tau_t, \qquad \tau_t = \bar{\tau} + \kappa(B_t^g - \bar{B})$$

- **Taxes reveal debt:** since τ_t is observed,

$$B_t^g = \bar{B} + \frac{\tau_t - \bar{\tau}}{\kappa}$$

- Households know debt level, but not if debt is stabilizing or just random

Return to setup Conclusion

Literature, theory

- Speak to three theoretical literatures mainly:
  1. **Behavioral Macro**: Angeletos and La'O (2013), Gabaix (2020), Guarda (2026), Angeletos and Huo (2021), Broer and Kohlhas (2024)
  2. **Sticky expectations**: Mankiw and Reis (2002), Carroll (2003), Carroll et al. (2020), Auclert et al. (2023)
  3. **Information frictions**: Lucas (1972), Lorenzoni (2009), Angeletos and La'O (2020), Kohlhas and Walther (2021), Adams and Rojas (2024), Sims (2003)
- RE learning about GE aggregates with HA, occasionally binding constraints
- **Method:** Marcet and Sargent (1989), Krusell and Smith (1998), Guarda (2026)

Back

KS Simulation, LOM accuracy

- Key: After converging on a_0, a_1, a_2, the law of motion has $R^2 = 0.999986$
- So w_t and μ_{t+1} together predict w_{t+1} with very high accuracy!
- It is also possible to compare this over time:
- Feed in a starting w_t and a series $\{\mu_t\}_{t=0}^{T}$, compare LOM and true series

Calibration Simulation results Back to main

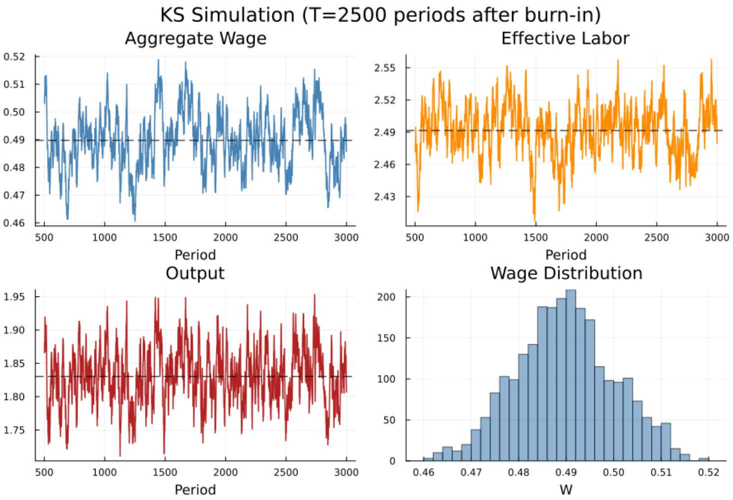
Calibration

Table 1: Model parameters, SOE model

Parameter	Value	Description
σ	2.0	Utility curvature (CRRA)
β	0.985	Discount factor
r	$(1/\beta - 1)/2$	Interest rate
α	$1/3$	Capital share
χ	0.1	Weight on leisure in utility
ϕ	1.5	inverse Frisch elasticity parameter
ρ	0.95	Persistence of productivity shocks
σ_μ	0.007	Std. dev. of productivity shocks
σ_e	0.15	Std. dev. of idiosyncratic efficiency shocks

Back

Simulation Results



Back

Impulse Responses, background

- Will mainly get impulse responses in two different ways:

1. Structural: Feed in a path of shocks $\mu = \{0, \dots, 0, \sigma_\mu, 0, \dots, 0\}$
    - Given policies, coefficients a_0, a_1, a_2
    - i.e. reach a stable point, then one off shock, then again $\mu = 0$
    - Agents behave "as–if" there were shocks continually, we just feed in a specific series
2. Local projection: Run on our simulated series, for $X \in \{W, N, Y, C\}$[1]

$$x_{t+h} - x_{t-1} = \alpha_h + \beta_h \mu_t + \sum_{k=1}^{p} \gamma_{k,h} \mu_{t-k} + \varepsilon_{t+h}, \quad h \geq 0$$

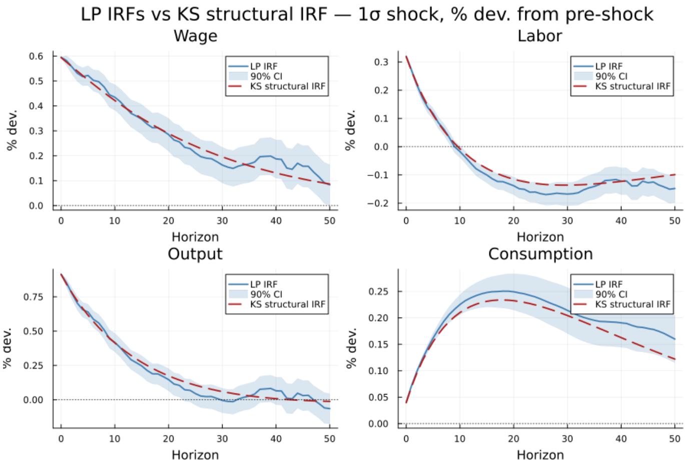
    - Then for IRF set $\mu_0 = \sigma_\mu$, and $\mu_1, \mu_2, \dots = 0$

- Main results: Structural IRFs used

Back

[1] Recall $x = \log X$

Local projection details



- MA(h) serial correlation, Newey–West standard errors with Bartlett kernel
- Confidence bands from: Critical value $z^* = \Phi^{-1}(1 - (1 - \texttt{conf})/2)$ Back