Cross-Sectional Household Heterogeneity in the Business Cycle

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Thanks to my advisor Mario Solis-Garcia, committee members Elizabeth Engle and Alisdair McKay, and the Macalester Honors cohort for helpful comments.

Motivation

Business Cycles

There are two causes for macroeconomic shifts

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Growth: Long-run trends

Business Cycles: Short-run fluctuations

RBC Models

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Standard RBC Model:

$$\text{Representative Household} + \text{Representative Firm} + \text{Effect of Interest}$$

$$= \text{Macro!}$$

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Inequality

People are not identical

- "The distribution of wealth in most countries for which there is reliable data is strikingly uneven." (Hubmer, Krusell, and Smith Jr 2021)

Heterogeneity in Macro

Household heterogeneity has significant effects on business cycles (McKay, Nakamura, and Steinsson 2016; Kaplan, Moll, and Violante 2018)

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- Redistribution Effects (Auclert 2019; Bayer, Born, and Luetticke 2024)

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Aggregate outcomes behave differently in models with heterogeneity

Questions

How do business cycle effects differ across the distribution of households?

How are the transmission channels for business cycle shocks different across the distribution?

Approach

1. Build a model of the macroeconomy with heterogeneity

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2. Fit the model to data

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1. Build a model of the macroeconomy with heterogeneity
2. Fit the model to data
3. Observe the behavior of different households

Model

HANK

I use a Heterogeneous Agent New Keynesian model

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Heterogeneous Agent: Model households differ in their levels of income and wealth

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New Keynesian: The model incorporates price and market frictions

Environment

Four types of agents:

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Households: Heterogeneous households choose to consume and save

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Firms: Produce goods for the economy

Government: Sets the fiscal and monetary agenda

Households

Households differ in their wealth and income levels

Households

Savings levels are decided to maximize expected utility

$$\max_{\{c_{i,t},b_{i,t}\}_{t=0}^{\infty}} \mathbb{E} \sum_{t=0}^{\infty} \underbrace{\beta^t}_{\text{Discounting}} \left[\underbrace{\frac{c_{i,t}^{1-\gamma}}{1-\gamma}}_{\substack{\text{Utility from} \\ \text{consumption}}} - \underbrace{\phi \frac{\ell_{i,t}^{1+\chi}}{1+\chi}}_{\substack{\text{Disutility from} \\ \text{labor}}} \right]$$

subject to the budget

$$\underbrace{b_{i,t}}_{\text{Savings}} + \underbrace{c_{i,t}}_{\text{Consumption}} = \underbrace{R_t b_{i,t-1}}_{\text{Returns}} + \underbrace{W_t z_{i,t} \ell_{i,t}}_{\text{Wages}} + \underbrace{D_t}_{\text{Dividends}} + \underbrace{\eta_t}_{\substack{\text{Govt.} \\ \text{Transfers}}} - \underbrace{\tau_t^L z_{i,t}^{\tau_t^P}}_{\text{Taxes}}$$

Households

Income levels are determined stochastically

$$\underbrace{\log z_{i,t}}_{\text{Current Productivity}} = \underbrace{\rho_z \log z_{i,t-1}}_{\text{Past Productivity}} + \underbrace{\epsilon_{z,i,t}}_{\text{Random Shock}}$$

Unions

Unions demand a uniform amount of labor from households

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This process creates wage rigidities in the wage Philips Curve

$$\log\left(\frac{\pi_t^W}{\overline{\pi}^W}\right) = \kappa^W\left(\phi L_t^{1+\chi} - \frac{1}{\psi_t^W} W_t L_t \int z c_t(b,z)^{-\gamma} d\Gamma_t(b,z)\right) + \beta \log\left(\frac{\pi_{t+1}^W}{\overline{\pi}^W}\right)$$

Firms

Monopolistically competitive firms produce goods using labor

$$y_{j,t} = A_t n_{j,t}$$

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Monopolistically competitive firms produce goods using labor

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Firms face price adjustment costs, which creates nominal rigidities in the Philips Curve

$$\log\left(\frac{\pi_t}{\overline{\pi}}\right) = \kappa\left(\frac{W_t}{A_t} - \frac{1}{\psi_t}\right) + R_{t+1}^{-1}\frac{Y_{t+1}}{Y_t}\log\left(\frac{\pi_{t+1}}{\overline{\pi}}\right).$$

Government

The government sets the fiscal and monetary policy

Government

As the fiscal authority, the government spends, gives transfers, offers bonds, and taxes households

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Bonds finance spending beyond the steady state

$$B_t = \underbrace{\overline{B}}_{\substack{\text{Steady State} \\ \text{Bonds}}} + \rho_B \Big(\underbrace{R_t B_{t-1} - \overline{RB} + G_t - \overline{G} + \eta_t - \overline{\eta}}_{\text{Out of Steady State Spending}} \Big)$$

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Taxes are set to balance the budget

$$\underbrace{R_t B_{t-1} + G_t + \eta_t}_{\text{Spending}} = \underbrace{\int \tau_t^L z^{\tau_t^P} d\Gamma_t^z(z) + B_t}_{\text{Income}}$$

Government

As the monetary authority, the government sets the interest rate

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The interest rate is set following a Taylor rule

$$I_t = \bar{I}\left(\frac{\pi_t}{\bar{\pi}}\right)^{\omega_\pi}\left(\frac{Y_t}{\bar{Y}}\right)^{\omega_Y}\xi_t$$

Shocks

Business cycles deviations are caused by exogenous shocks to

- TFP (A_t)
- Price Markups (ψ_t)
- Wage Markups (ψ_t^W)
- Government Spending (g_t)
- Monetary Policy (ξ_t)
- Tax Progressivity (τ_t^P)
- Transfers (η_t)

Equilibrium

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1. Bonds provided by the government equals household savings
2. Labor provided by unions equals that used by firms
3. Goods produced by firms equals consumption by households and government spending

Parameterization

Approach

“Calibrate, then estimate”

Approach

1. Calibrate micro-parameters
    - Based on literature and targeted moments

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1. Calibrate micro-parameters
    - Based on literature and targeted moments
2. Estimate business cycle effects
    - Perform a Bayesian estimation in the sequence space

Estimation Strategy

Assume a Gaussian AR(1) process for every shock

Parameter	Meaning	Prior
ρ	Persistence	Beta(0.5, 0.15)
σ	Standard Deviation	Inv. Gamma(0.2, 2)

Data

Fit the model to seven aggregate detrended time series from FRED

- GDP (Y_t)
- Inflation (π_t)
- Federal Funds Rate (I_t)
- Hours Worked (N_t)
- Consumption (C_t)
- Debt (B_t)
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No Microdata!

Business Cycles

Estimated Business Cycles

Within the estimated business cycles in the model, each series is affected by a different set of shocks

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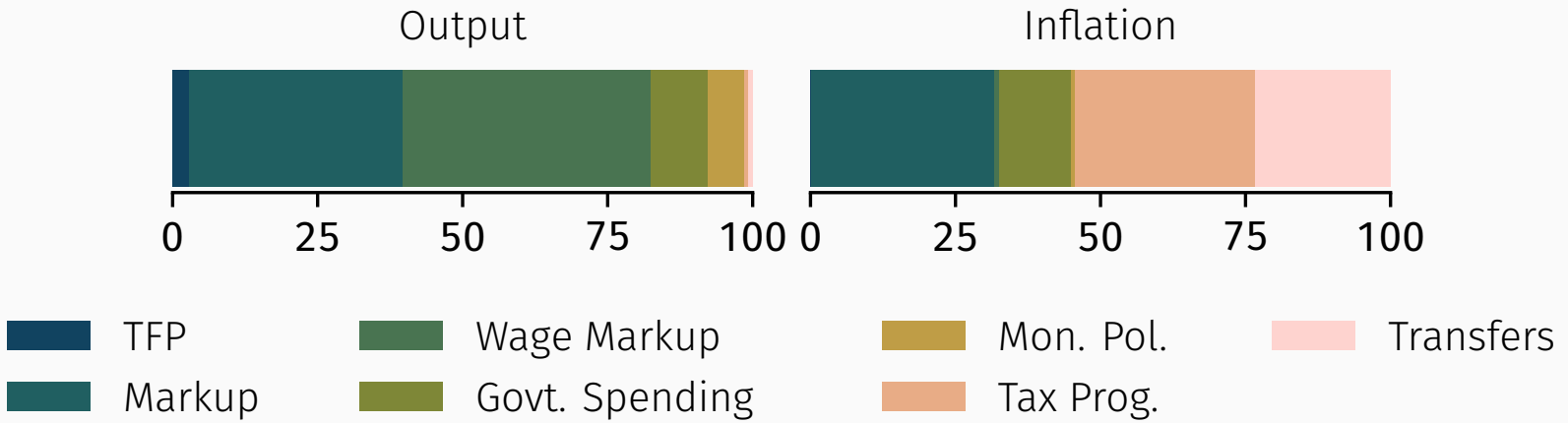

Forecast error variance decompositions calculated at a 4 quarter time horizon

Household Decisions

Business cycles affect household consumption and savings decisions

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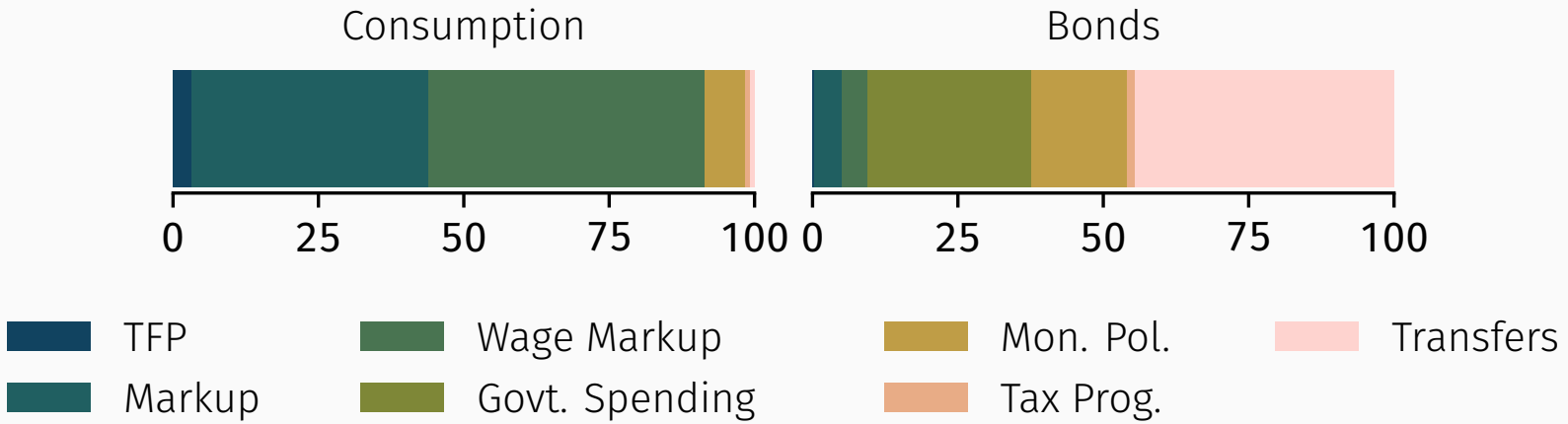

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Heterogeneity

To analyze heterogeneity within business cycles, look at the set of shocks that affect different households

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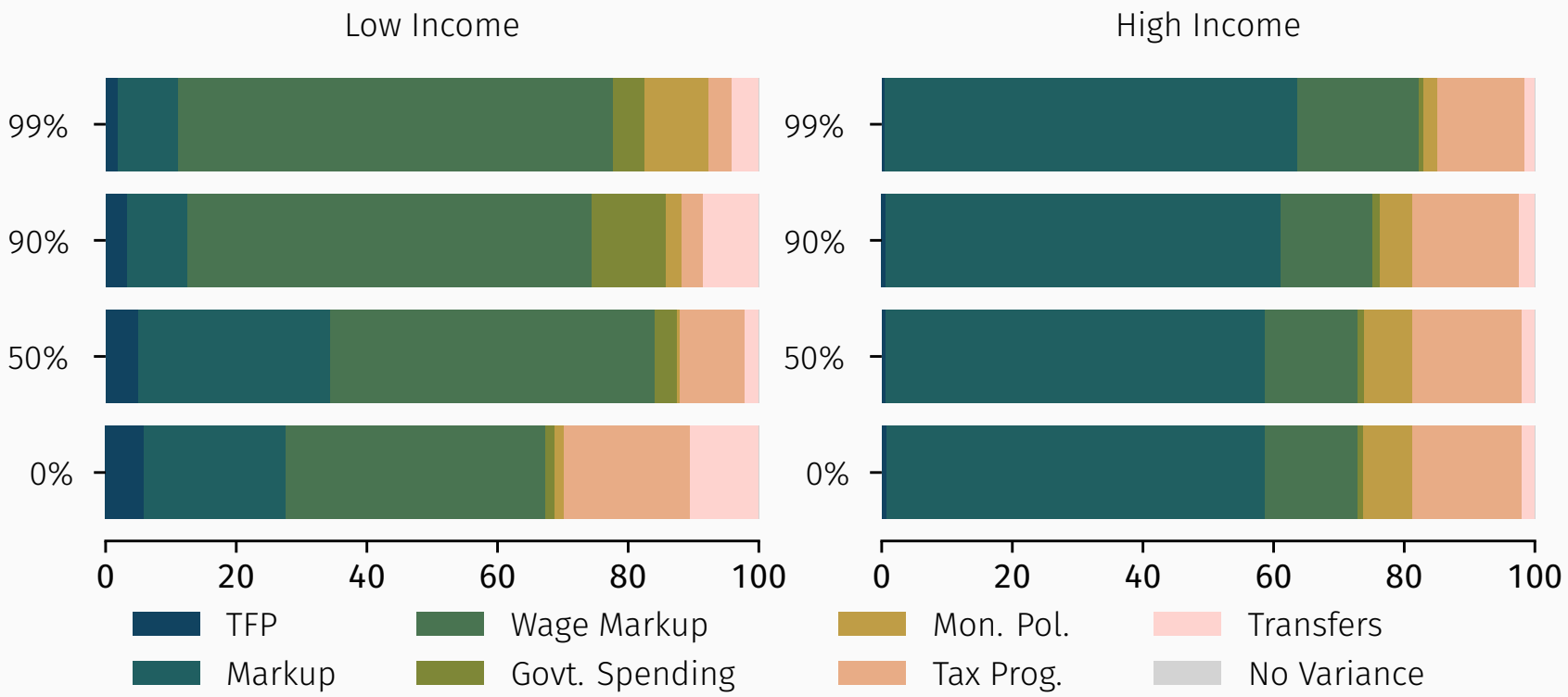
Wealth: Households at the 0th, 50th, 90th, and 99th percentiles

Income: Low and high income households

Consumption Heterogeneity



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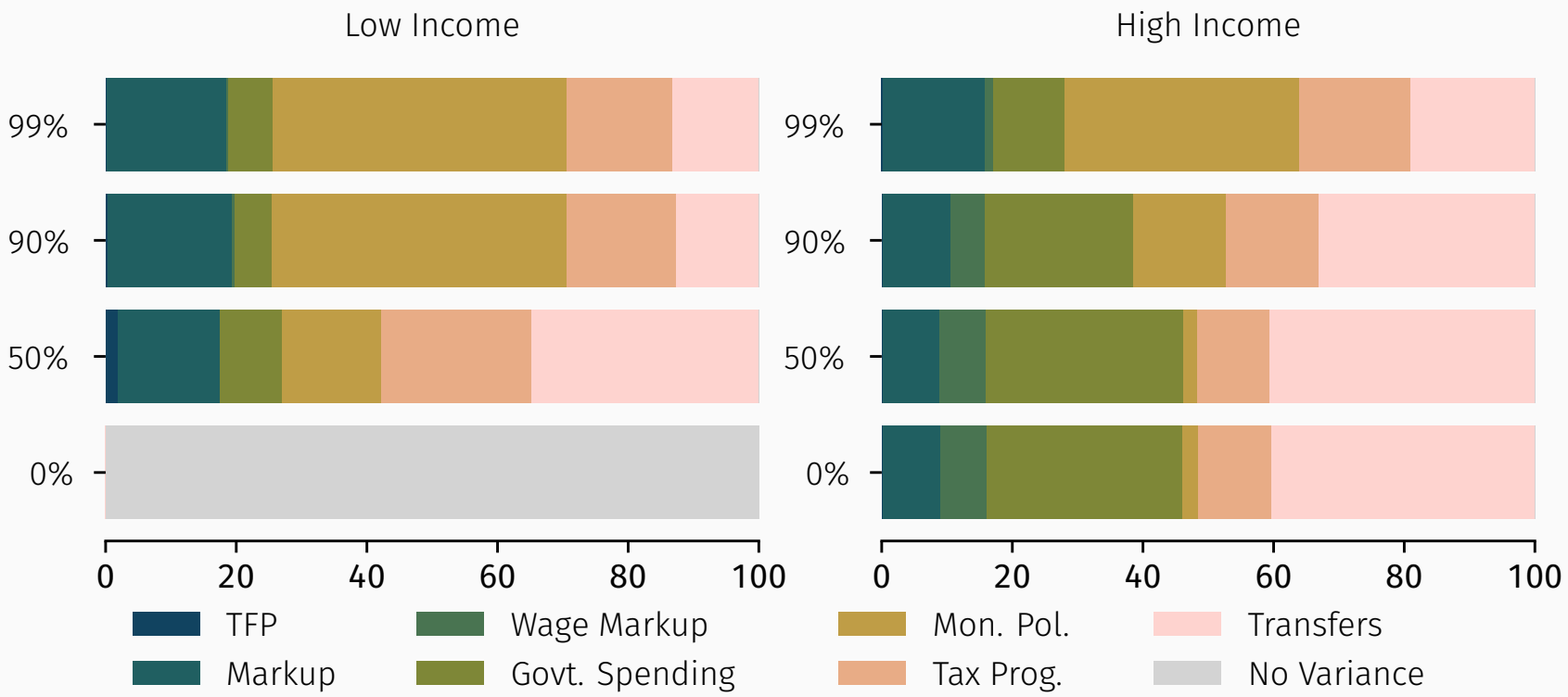
Savings Heterogeneity



Forecast error variance decompositions calculated at a 4 quarter time horizon

Historical Decompositions

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Solve for a sequence of shocks to the model that match the observed data

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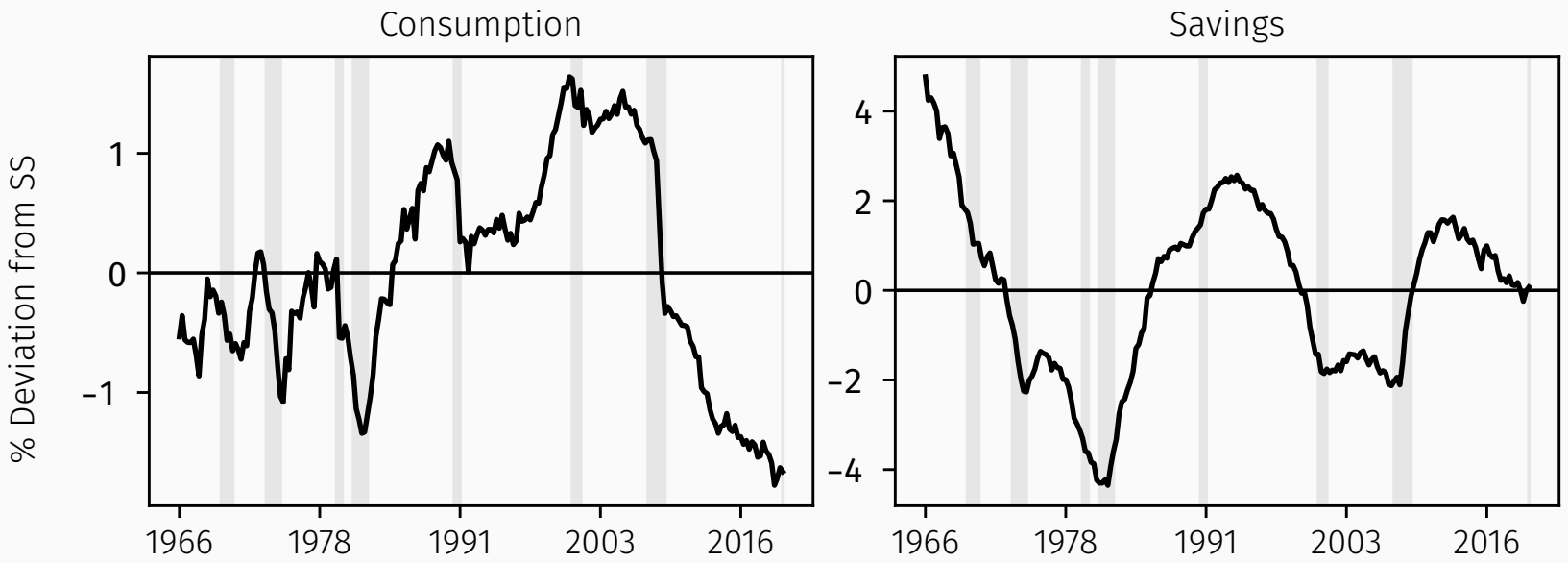
$$\min_{\varepsilon} \quad \sum_{t=0}^{T_{obs}} \left\| dX_t^{data} - d\tilde{X}_t \right\|^2$$

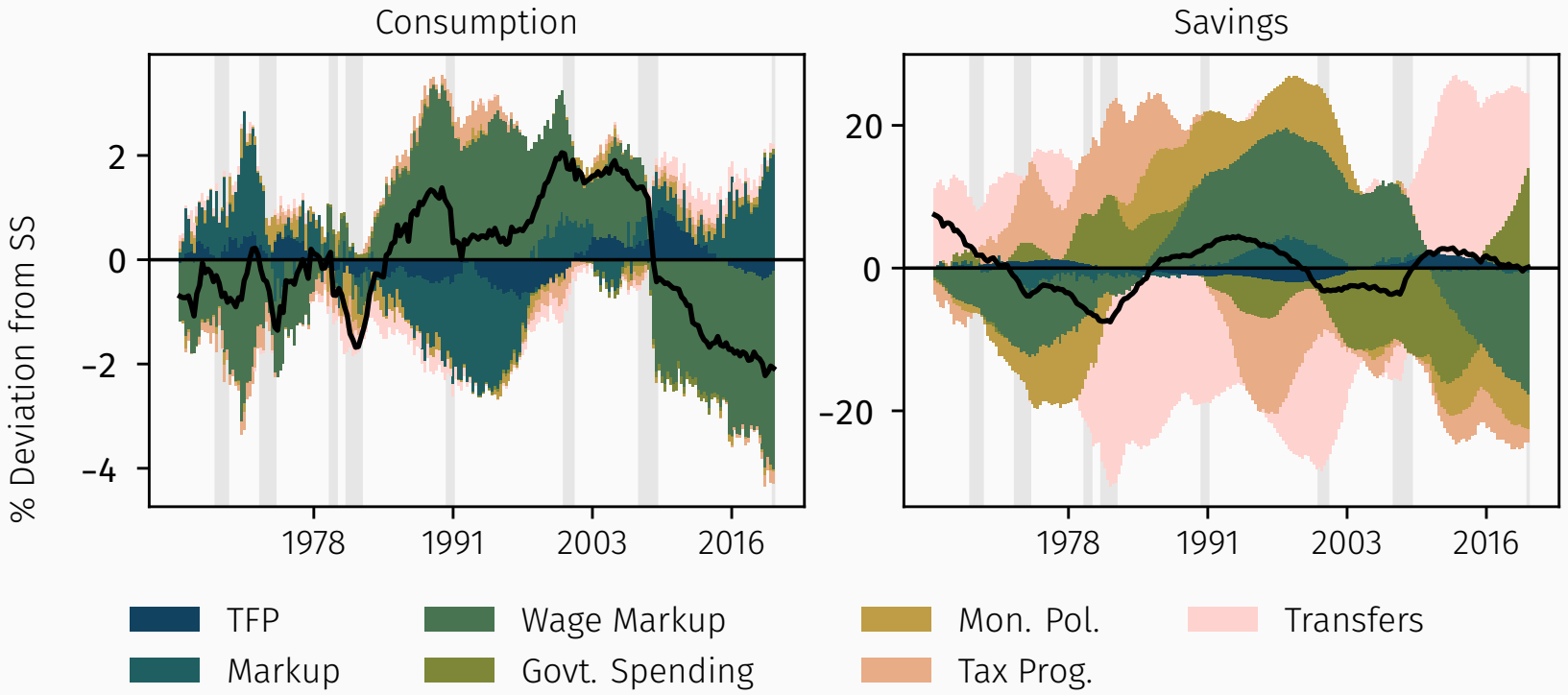
$$\text{subject to} \quad d\tilde{X}_t = \sum_{s=0}^{T} dX_s \varepsilon_{t-s}$$

Data



NBER-dated recessions highlighted in gray

Decomposition



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Simulation

Using the series of shocks, simulate different household's responses

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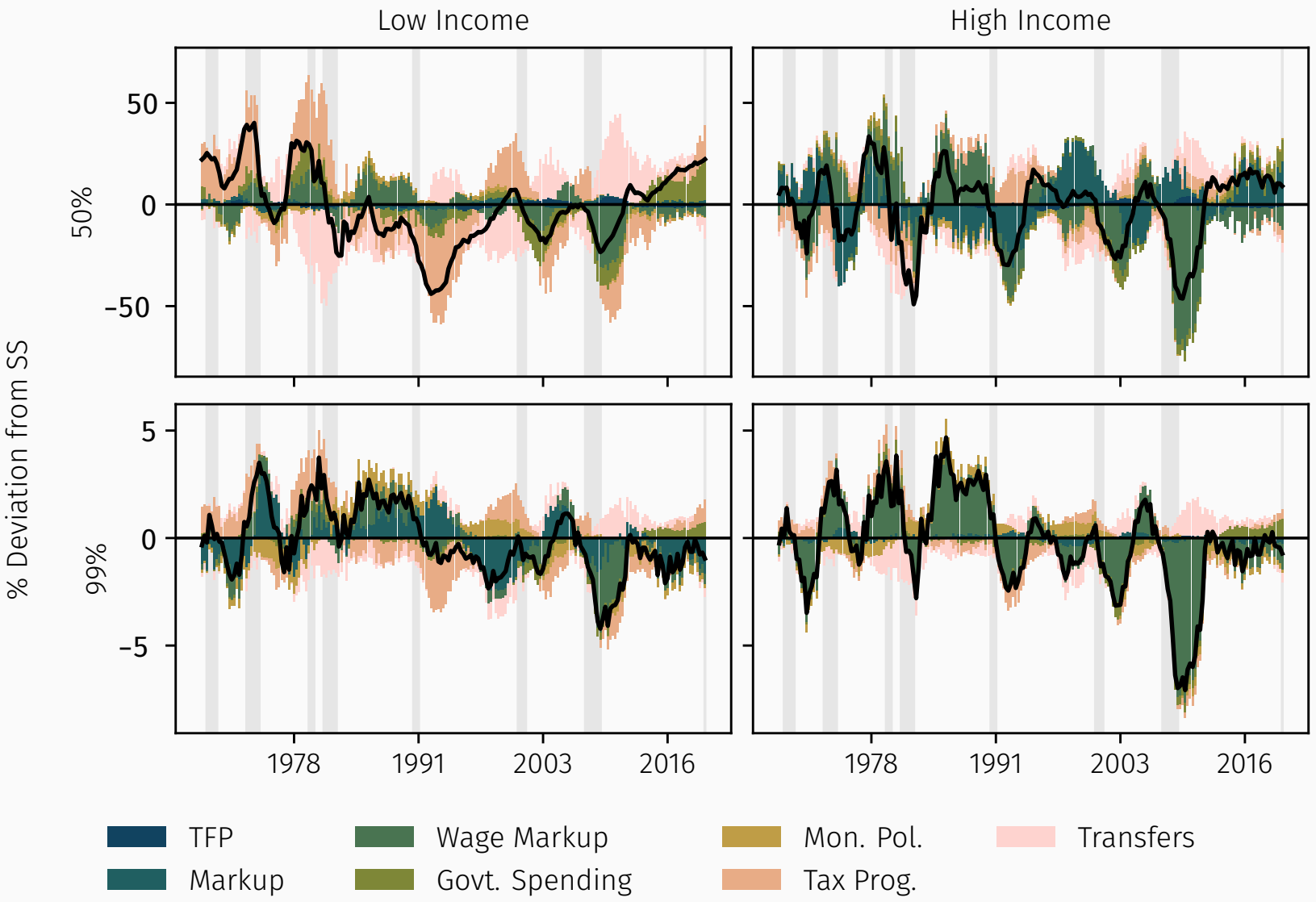
This is only a simulation and not fit to real data

Consumption

NBER-dated recessions highlighted in gray

Savings



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Transmission Channels

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Households don't directly respond to the shocks

Transmission Channels

Households don't directly respond to the shocks

They respond to the macroeconomic conditions created by the shock

Decomposition

Decompose changes in household consumption using

$$dC = \underbrace{\frac{\partial C}{\partial L} dL}_{\text{Labor Effects}} + \underbrace{\frac{\partial C}{\partial W} dW}_{\text{Wage Effects}} + \underbrace{\frac{\partial C}{\partial R} dR}_{\text{Interest Effects}} + \underbrace{\frac{\partial C}{\partial D} dD}_{\text{Dividend Effects}} + \underbrace{\frac{\partial C}{\partial \eta} d\eta}_{\text{Govt. Transfer Effects}} + \underbrace{\frac{\partial C}{\partial \tau^P} d\tau^P}_{\text{Tax Progressivity Effects}} + \underbrace{\frac{\partial C}{\partial \tau^L} d\tau^L}_{\text{Tax Level Effects}}$$

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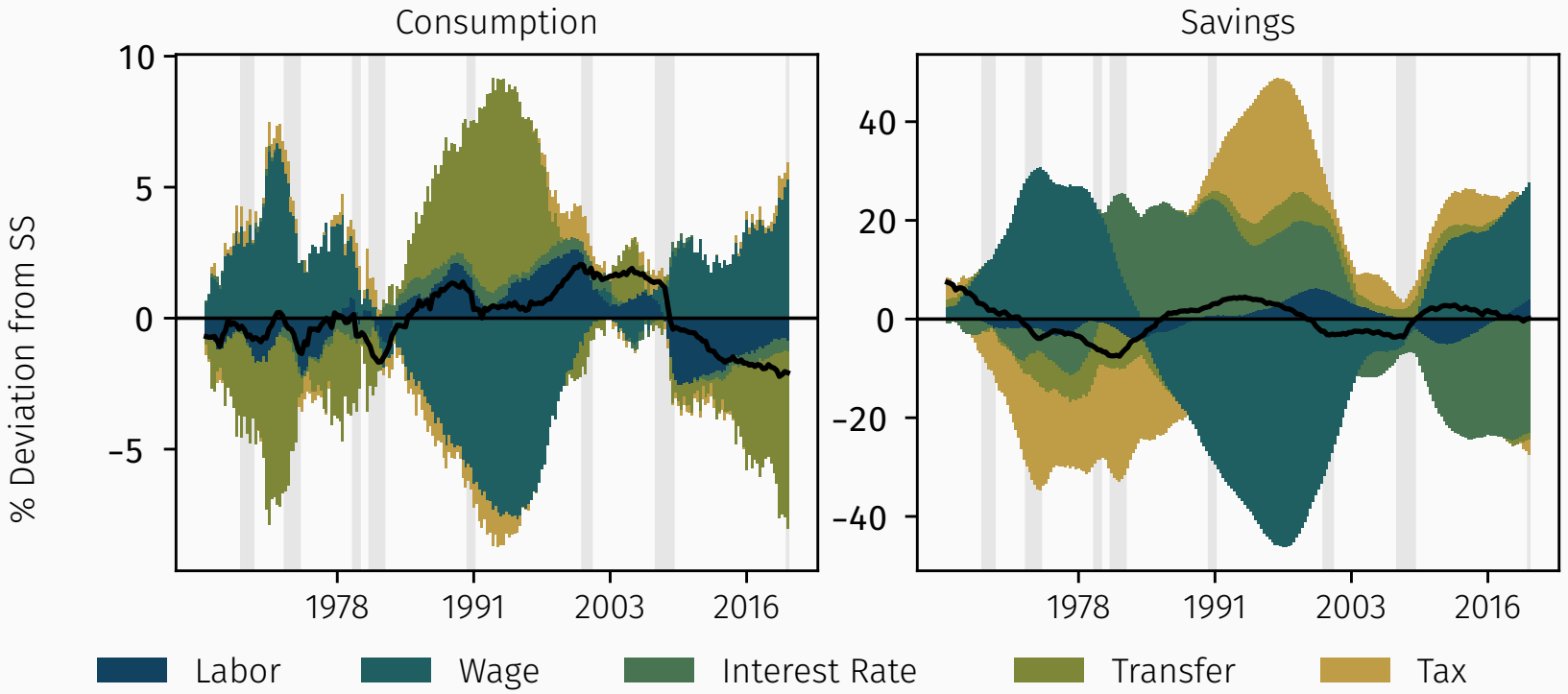
Decomposition



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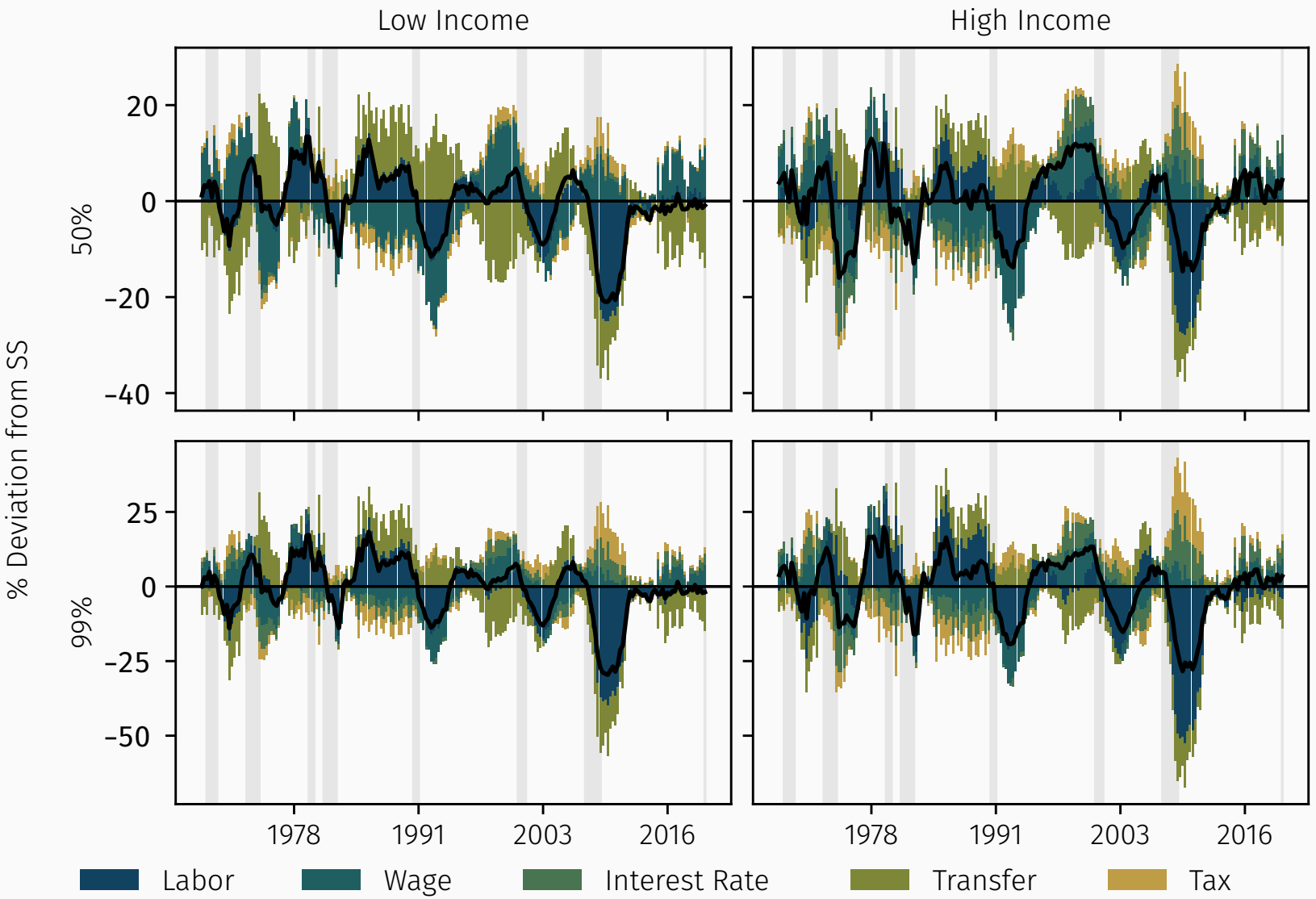
Heterogeneity

We can decompose the responses for individual households using this same process

Consumption



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Savings

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Conclusion

Findings

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Findings

1. Household consumption decisions are affected differently by business cycles across income levels
2. Changes in savings decisions vary the most across wealth levels
3. During the the 80s, the effects of business cycle factors flipped
4. The factors that affect different households vary

   Low Income/Wealth: Income (Transfers, Wages)
   High Income/Wealth: Tradeoffs (Monetary Policy, Prices)

Thanks!

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