Wealth, Search, and Human Capital over the Business Cycle

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Motivation

- Recessions have persistent effects on earnings
  - Enter labor market in recession $\rightarrow$ persistent earnings loss
    - Kahn (2010), Wee (2014), Guo (2014), ...
  - Job loss $\rightarrow$ persistent earnings losses
    - Cost of displacement: Jacobson et al (1993)
    - Amplified in recessions: Davis and von Wachter (2011)
    - (Occupation change costly: Baley, Figueiredo, Mantovani, Sepahsalari)
- Recessions have differential effects by wealth
  - Consumption (hence welfare) losses larger for poorer agents
    - Krueger, Mitman & Perri (2016)
  - Earnings growth slows more during recessions for wealth-poor
    - this paper
- How do wealth and recessions interact?

What We Do

- **Here**: explore how wealth shapes recessions and earnings losses
- Incomplete-market job ladder model:
  - directed search on & off the job
  - life-cycle Ben-Porath human capital accumulation
  - risk aversion & borrowing constraints
  - aggregate productivity shocks
- Questions
  - How do business cycles affect
    - Job search?
    - Human capital accumulation?
  - How do these effects differ by wealth?

Mechanisms

1. Job search of the unemployed
   - Workers face tradeoff between wage and job-finding probability
   - Low-wealth workers $\rightarrow$ lower-wage jobs
   - Exacerbated in recession
   - Unemployment $\rightarrow$ more persistent earnings loss for poor agents

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   - Unemployment risk $\rightarrow$ self-insurance motive
     - Precautionary saving $\uparrow$, HC $\downarrow$
     - Stronger for poor workers

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     - Poor workers: **self-insurance** motive $\rightarrow$ human capital $\downarrow$

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   - **Recession amplifies inequality in human capital by wealth**

Model environment

- Workers: risk-averse, finitely lived, heterogeneous in a, h, ℓ, $t = 1, ..., T$, emp. status $\in \{E, U\}$, UI $n \in \{0, 1\}$, piece-rate μ
  - Search on and off job for piece-rate $\mu \rightarrow$ job ladder
  - Save and borrow at exogenous r_F, s.t constraint $a' \geq -\underline{a}_t$
  - Employed: time for production $(1 - \tau)$ or HC accumulation (τ)
  - Unemployed & employed: stochastic HC depreciation
  - Initial distribution of a_0, h_0, ℓ
- Firms and production
  - Risk-neutral firms, same discount β as workers
  - Post vacancies at cost κ specifying piece-rate contracts
  - Directed search in labor market
  - Worker-firm match produces $(1 - \tau) zh$
  - Aggregate shocks: $ln(z') = \rho_z ln(z) + \epsilon_z$, $\epsilon_z \sim N(0, \sigma_Z)$

Search and Matching Technology

- Directed search
  - First post fixed piece-rate contracts μ at per-vacancy cost κ
  - Workers decide where to apply
- Submarkets indexed by (a, h, ℓ, t) and piece-rate (μ)
- Matching technology:
  - CRS matching function $M_t = M(s_t, v_t)$
  - Submarket tightness: $\theta_t = \frac{v_t}{s_t}$
  - Vacancy filling rate: $q(\theta_t) = \frac{M(s_t, v_t)}{v_t}$
  - Job finding rate: $p(\theta_t) = \frac{M(s_t, v_t)}{s_t} = \theta_t q(\theta_t)$
- Employed workers can search on the job with probability λ_E

Unemployed Worker's Problem

$$U_t^n(z, b_{UI}, a, h, \ell) = \max_{c, a' \geq -\underline{a}_t} u(c) + \beta \mathbb{E} R_{t+1}^{U,n'}(z', b'_{UI}, a', h', \ell)$$

subject to

$$c + a' \leq (1 + r_F)a + nb_{UI} + (1 - n)b_L$$

$$h' = e^{\epsilon'} h, \quad \epsilon' \sim N(\mu_\epsilon, \sigma_\epsilon)$$

$$n' = 0 \text{ with prob. } \gamma \text{ if } n = 1, \; n' = 0 \text{ if } n = 0$$

$$\ln(z') = \rho_Z \ln(z) + \epsilon_z, \quad \epsilon_z \sim N(\mu_z, \sigma_z)$$

- (note: for n $= 0$, b_{UI} not a state)

Unemployed Searcher's Problem

$$R_t^{U,n}\left(z, b_{UI}, a, h, \ell\right) = \max_{\mu'} p\left(\theta_t\right) W_t\left(z, \mu', a, h, \ell\right) + \left(1 - p\left(\theta_t\right)\right) U_t^n\left(z, b_{UI}, a, h, \ell\right)$$

where $\theta_t = \theta_t\left(z, \mu', a, h, \ell\right)$

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- Apply for job with piece-rate μ'
- Understand that higher $\mu' \rightarrow$ lower θ
- Tradeoff between wage and job-finding probability
- Lower $a \rightarrow$ apply for lower μ'
- Lower $z \rightarrow$ apply for lower μ', more so if low a

Employed Worker's Problem

$$W_t(z,\mu,a,h,\ell) = \max_{c,a' \geq -\underline{a}_t,\tau} u(c) + \beta \mathbb{E}\Big[(1-\delta) R_t^E(z',\mu,a',h',\ell) + \delta R_t^{U,1}(z',b_{UI},a',h',\ell)\Big]$$

subject to

$$\begin{aligned} c + a' &\leq (1+r_F)a + (1-\tau)\mu z h \\ h' &= e^{\epsilon'}\left(h + \ell(h\tau)^{\alpha}\right), \quad \epsilon' \sim N(\mu_\epsilon, \sigma_\epsilon) \\ b_{UI} &= \max\{\min\{b(1-\tau)\mu z h, \bar{b}\}, b_L\} \\ \ln(z') &= \rho_Z \ln(z) + \epsilon_z, \quad \epsilon_z \sim N(\mu_z, \sigma_z) \end{aligned}$$

Human capital: mechanism

$$W_t(z,\mu,a,h,\ell) = \max_{c,a' \geq -\underline{a}_t,\tau} u(c) + \beta \mathbb{E}\Big[(1-\delta) R_t^E(z',\mu,a',h',\ell) + \delta R_t^{U,1}(z',a',h',\ell)\Big]$$

subject to

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- Substitution effect:
  $z \downarrow \implies$ opportunity cost of training $\downarrow$
- Precautionary motive:
  $z \downarrow \implies$ unemployment risk $\uparrow \implies$ benefit of h' relative to a' $\downarrow$

Employed Worker's Problem

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On-the-job search:

$$R_t^E(z,\mu,a,h,\ell) = \max_{\mu'} \lambda_E p(\theta_t) W_t(z,\mu',a,h,\ell) + (1-\lambda_E p(\theta_t)) W_t(z,\mu,a,h,\ell)$$

where $\theta_t = \theta_t(z,\mu',a,h,\ell)$

Firms and equilibrium

- Value of a matched firm:

$$J_t(z, \mu, a, h, \ell) = (1-\mu)(1-\tau) zh + \beta \mathbb{E}(1-\delta)(1-\lambda_E p(\theta_t)) J_{t+1}(z', \mu, a', h', \ell)$$

subject to laws of motion for z, a, h, and $\theta_t = \theta_t(z, \mu, a, h, \ell)$

- Free entry:

$$\kappa = q(\theta_t(z, \mu, a, h, \ell)) J_t(z, \mu, a, h, \ell) \quad \forall (z, \mu, a, h, \ell)$$

- Markets segment by worker characteristics
  $\Longrightarrow$ **block-recursive equilibrium**

Equilibrium

A *Block Recursive Equilibrium* (BRE) in this model is a set of value functions, $U_t, W_t, R_t^E, R_t^U, J_t, V_t$, associated policy and market tightness functions, a', c, μ', τ, and θ_t, which satisfy

1. The policy functions $\{c, \mu', a', \tau\}$ solve the workers problems, W_t, U_t, R_t^E, R_t^U.
2. $\theta_t(\mu, a, h, \ell)$ satisfies the free entry condition for all submarkets (μ, a, h, ℓ, t).
3. The aggregate law of motion is consistent with all policy functions.

(Key insight: contracts indexed by worker state $\rightarrow$ distribution of agents not state variable. Can be recovered by simulation.)

Calibration Overview

- Estimate HC technology and initial heterogeneity using
  - Life-cycle earnings profiles
  - Observable job search behavior
  - Observable distributions of initial conditions
- From stationary analogue of model.
- Estimate ρ_z, σ_z targeting AR1 process for labor productivity with stochastic model.

Calibration

- Functional forms:
  - Power utility: $u(c) = \frac{c^{1-\sigma}-1}{1-\sigma}$
  - Natural borrowing constraint: $\underline{a}_t = \sum_{j=t}^{T} \frac{b_L}{(1+r_F)^j}$
  - $(a_0, h_0, \ell) \sim LN(\psi, \Sigma)$, correlations $\rho_{AH}, \rho_{A\ell}, \rho_{H\ell}$
- Model parameters:
  - Quarterly over ages 23-65, $\sigma = 2$, $r_F = 0.012$, $\beta = \frac{1}{1+r_F}$
  - Key parameters:
    - Age-23 constraint: $\underline{a}_0 = -\$6,359$ (2011\$)
    - Search efficiency: $\lambda_E = 0.588$.
    - Corrs.: $\rho_{AH} = 0.325$, $\rho_{A\ell} = 0.464$, $\rho_{H\ell} = 0.691$.
- Aggregate productivty (estimated): $\rho_Z = 0.9125$, $\sigma_Z = 0.0047$

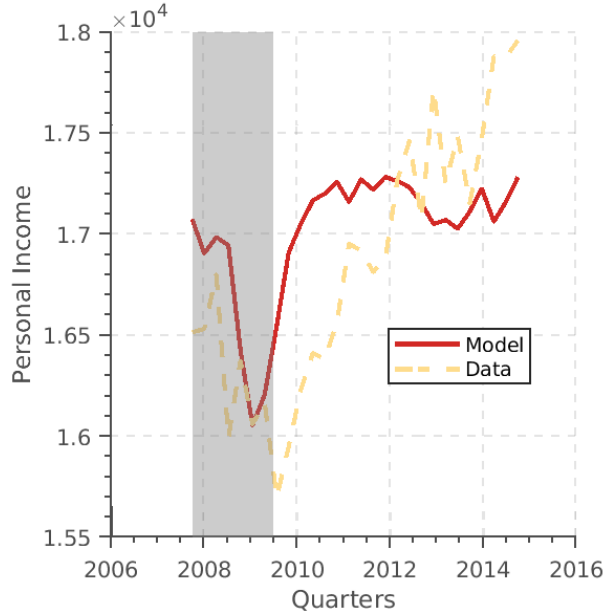
Non-Targeted Cyclicality and Variability

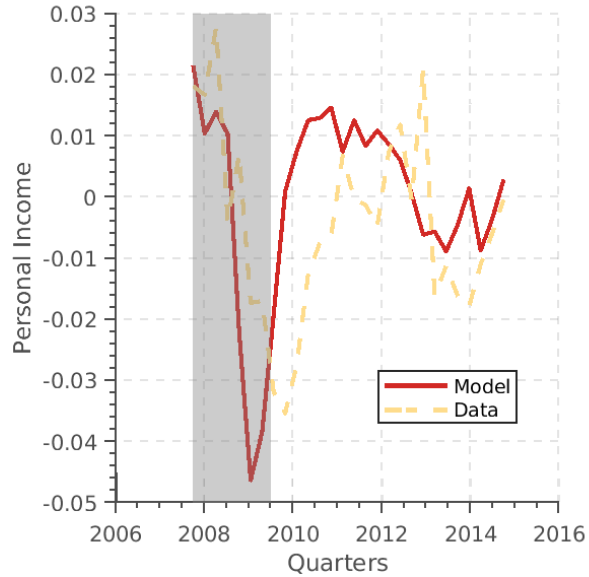
Table: Cyclicality and Variability

	Persistence		Standard Deviation	
Var.	Data	Model	Data	Model
Labor Prod.	0.7359	0.7289	0.0125	0.0080
Income	0.6092	0.7609	0.0156	0.0158
Consumption	0.6761	0.6913	0.0084	0.0072
Unemp.	0.9191	0.7147	0.1172	0.0831

Calculated from aggregate time series.

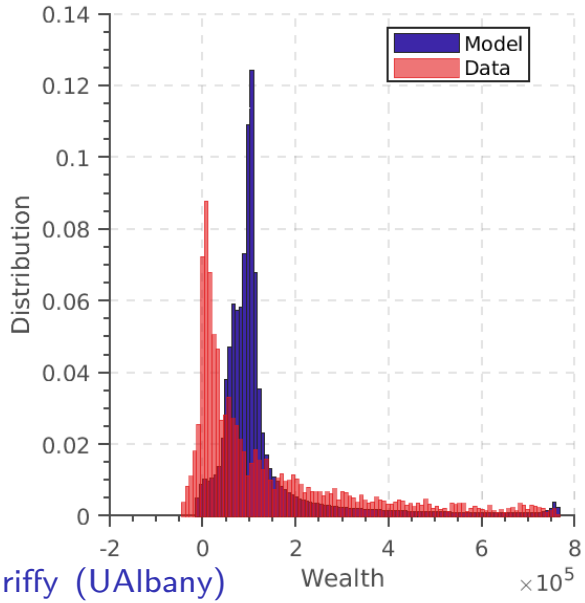
Non-Targeted Moments

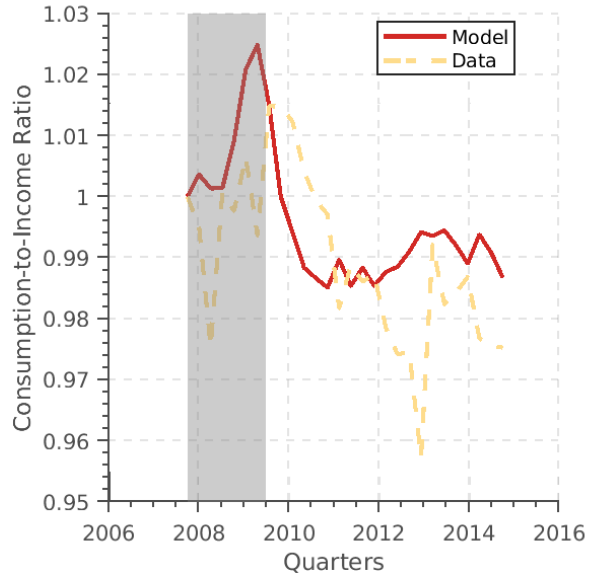




Lvls.: Inc. ↑, Liq. Wealth ↓

Cyc.: Inc. ↑, Cons/Inc (norm) ↓





Quantitative Experiments

- Start economy in steady-state.
- Focus on two components:
  - Effect of large recession on aggregate economy.
  - How consequences are shared across wealth distribution.
- Large recession: 2 SD shock that lasts for 6 quarters ($\approx$ GR)
- Explore distributional effects by wealth:
  - Compare effect of recession on new entrant workers.
  - workers differ only by wealth and start employed.
- Consider alternate wealth distributions:
  - 5% mean preserving spread decrease/increase
  - How do alternate wealth distributions affect recessions?

Effect of a Big Recession (-3.25pp) on GDP

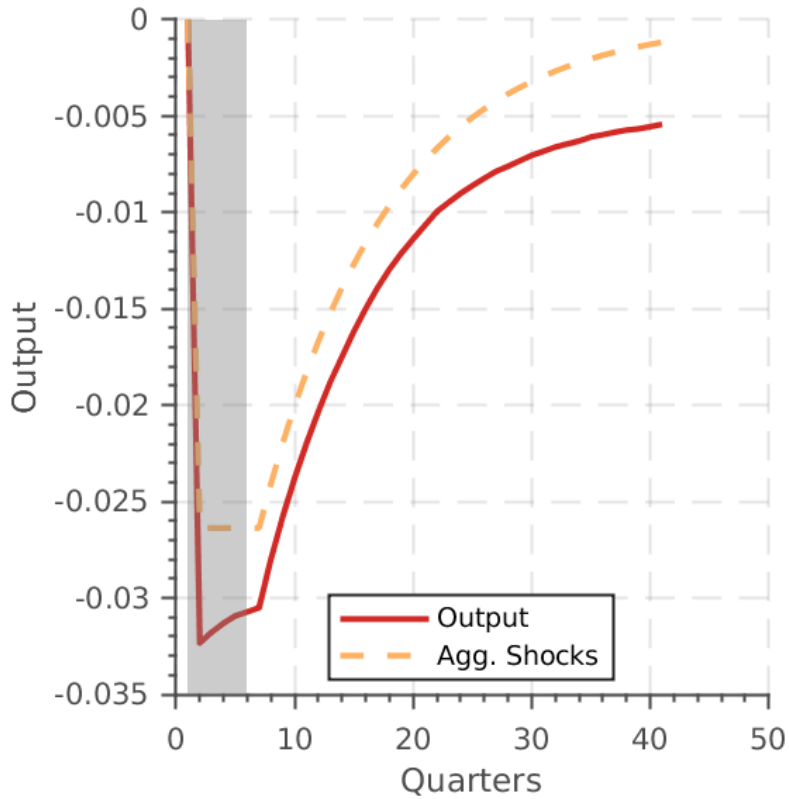
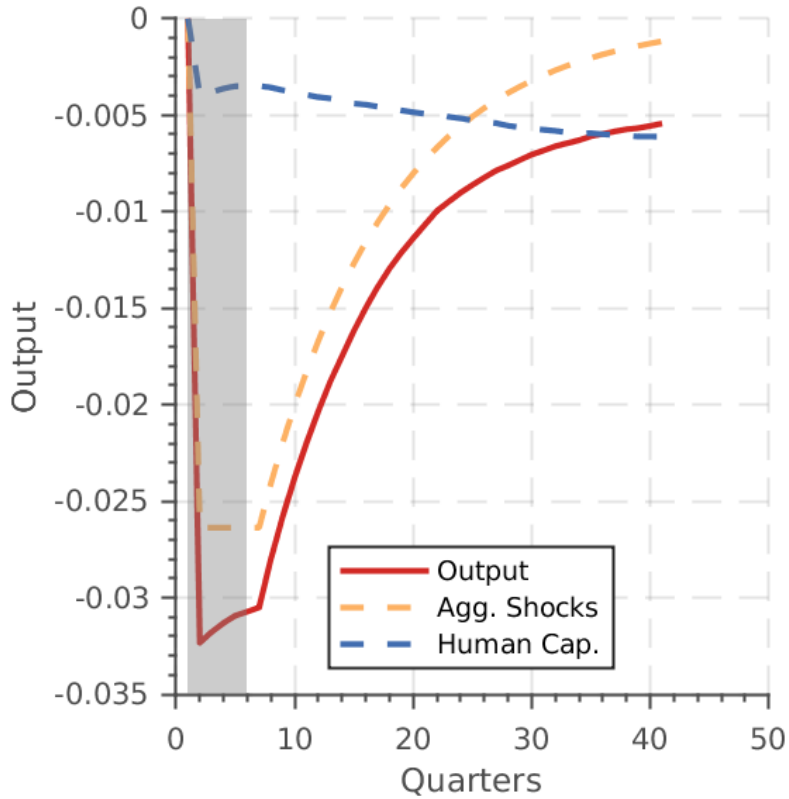


Figure: GDP Change Decomposition

- Agg. Shocks play large immediate role in output.

Effect of a Big Recession on GDP



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- Agg. Shocks play large immediate role in output.
- Agg. human capital permanently declines.

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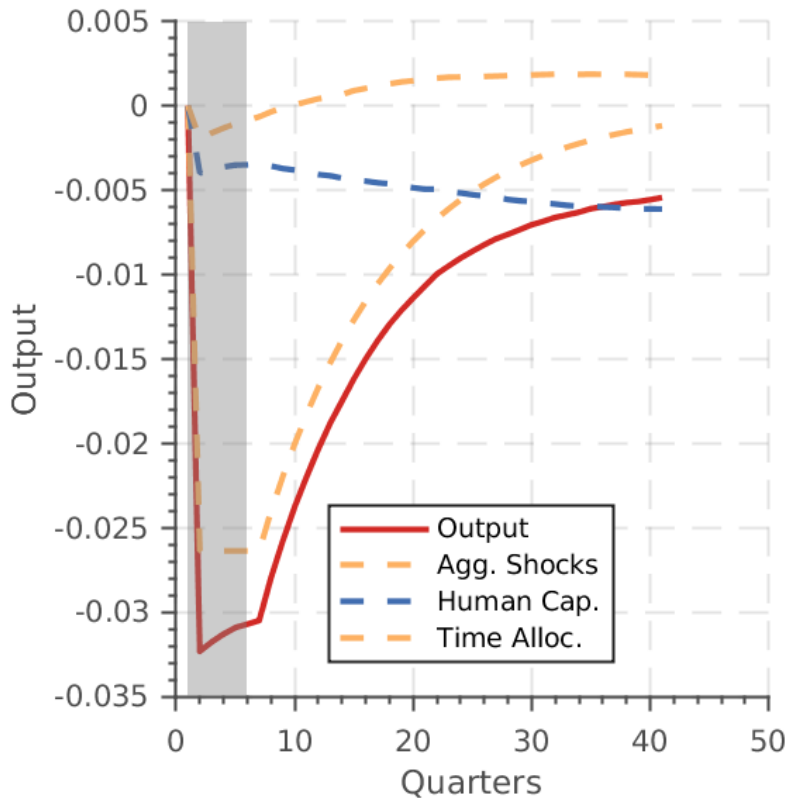

Figure: GDP Change Decomposition

- Agg. Shocks play large immediate role in output.
- Agg. human capital permanently declines.
- Recovery: productive time $\uparrow \rightarrow$ GDP $\uparrow$, but slows HC growth.

Effect of Aggregate Shock on Income Components

Table: Average change relative to steady-state economy

Variable	End of recession	8 years later
Employment	-6.82%	0.03%
Human Capital, h	-0.96%	-1.00%
Piece Rate, μ	-8.90%	-0.46%
Learning Time, τ	0.35%	-0.88%
Application Strategy, μ'	-13.16%	-0.12%

- Employment recovers, lost human capital investment does not.
- Lost human capital: decreased investment & extended unemployment.

Effect by Wealth Quintile

Table: Average change by wealth quintile relative to steady-state economy

Variable	End of recession 1st	End of recession 5th	8 years later 1st	8 years later 5th
Employment	−17.19%	−1.82%	−0.15%	0.14%
Human Capital, h	−2.35%	−0.29%	0.04%	0.14%
Piece Rate, μ	−26.95%	−1.63%	−5.10%	−0.07%
Learning Time, τ	−19.14%	5.24%	2.18%	0.01%
Application Strategy, $\mu\prime$	−32.10%	−3.11%	−0.92%	0.08%

- Wealth quintiles defined each period in each economy.
- Shock hits asymmetrically across wealth dist.
- Composition effects:
  - Selection: correlation between wealth and productivity.
  - Cohort effect: Wealthier workers are older, fewer new entrants, higher on job ladder.

Understanding the Composition Effects

Table: Ave. change by initial wealth qtile relative to steady-state economy

Variable	End of recession 1st	End of recession 5th	Lifetime Average 1st	Lifetime Average 5th
Human Capital, h	-3.18%	-2.70%	-2.45%	-2.10%
Piece Rate, μ	-27.41%	-24.44%	-2.37%	-2.23%
Productive Time, $(1-\tau)$	2.89%	2.23%	0.41%	0.38%

- Basic counterfactual:
  - Only wealth heterogeneity: $\sigma_\ell = 0$, $\sigma_H = 0$.
  - Same recession at beginning of life-cycle.
- Differences are small, but entirely due to wealth.
- Could still interact with h and ℓ correlations.

Effect on GDP with Less Wealth Dispersion

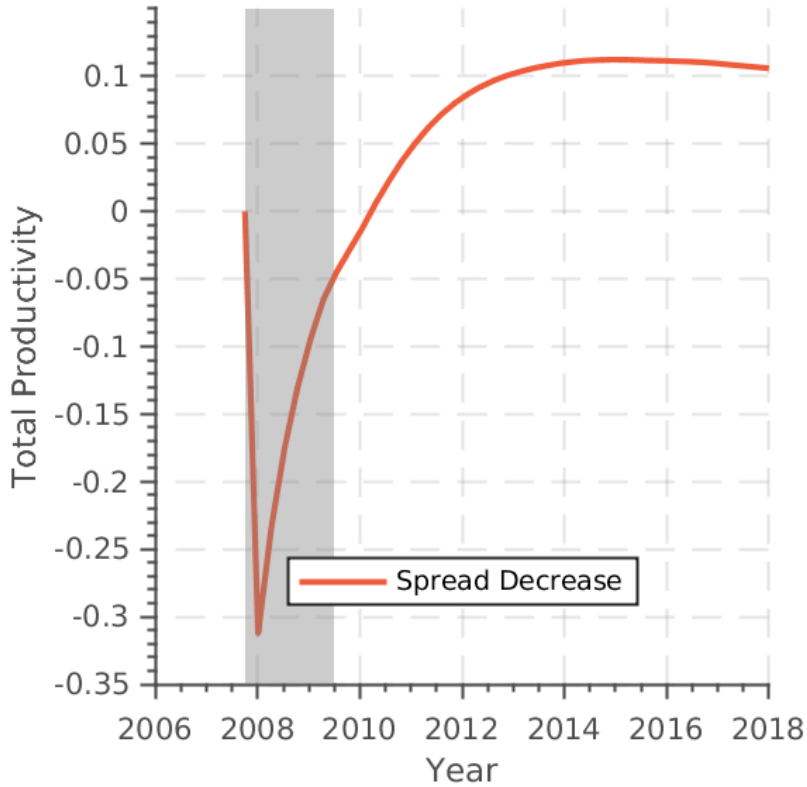

Figure: Pct. Change in GDP Rel. to Baseline

- *Larger* initial effect on output (note: -0.3%).
- *Long-term positive effect.*

Effect on Human Capital Investment

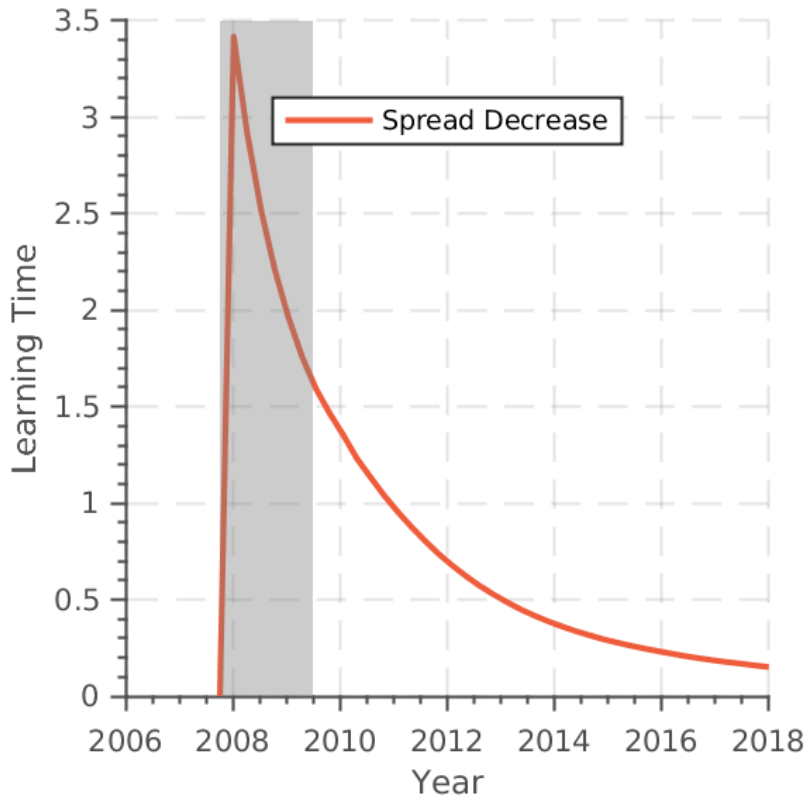

Figure: Pct. Change in τ to Baseline

- Substitution effect dominates:
  - More human capital investment!
  - $\rightarrow$ less productive time, less output.
- How does this vary by wealth?

How changes by wealth drive results

- Compare MPS to baseline impulse response.
- Calculated as average difference over model horizon (10 years).
- Results are Pct. change relative to baseline IR.

Table: Distributional Effects of MPS

Variable	Employed 1st	Employed 5th	Unemployed 1st	Unemployed 5th
5% *Decrease*				
Human Capital	1.15%	0.01%	0.47%	0.15%
Learning Time	4.86%	−0.61%	NA	NA
Application Strategy	−0.04%	0.03%	0.70%	0.07%
Transition Rate	−0.05%	−0.38%	−0.29%	0.12%
5% *Increase*				
Human Capital	−1.14%	−0.00%	−0.43%	−0.14%
Learning Time	−4.62%	0.68%	NA	NA
Application Strategy	0.05%	−0.02%	−0.67%	−0.08%
Transition Rate	0.04%	0.44%	0.27%	−0.13%

Summary

- Incomplete-markets framework with endogenous earnings process
- Effects of recessions uneven by wealth
- Persistence of earnings loss from recession larger for poorer workers
- Wealth inequality changes dynamics of recessions
- Ongoing work:
  - Dig more into individual outcomes.
  - Compare to unemployment/recession scarring literature.
  - Further decompose composition effects.